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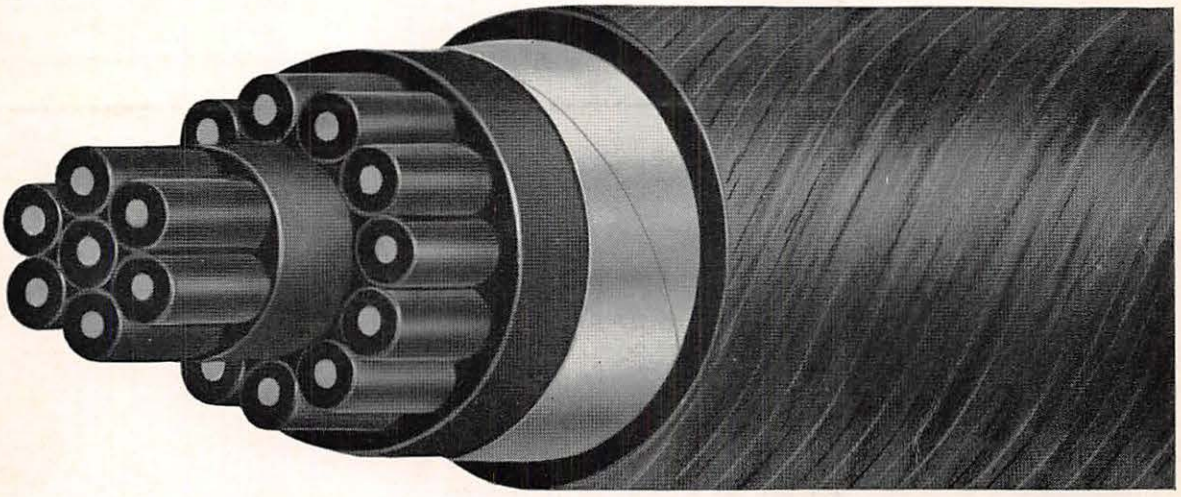

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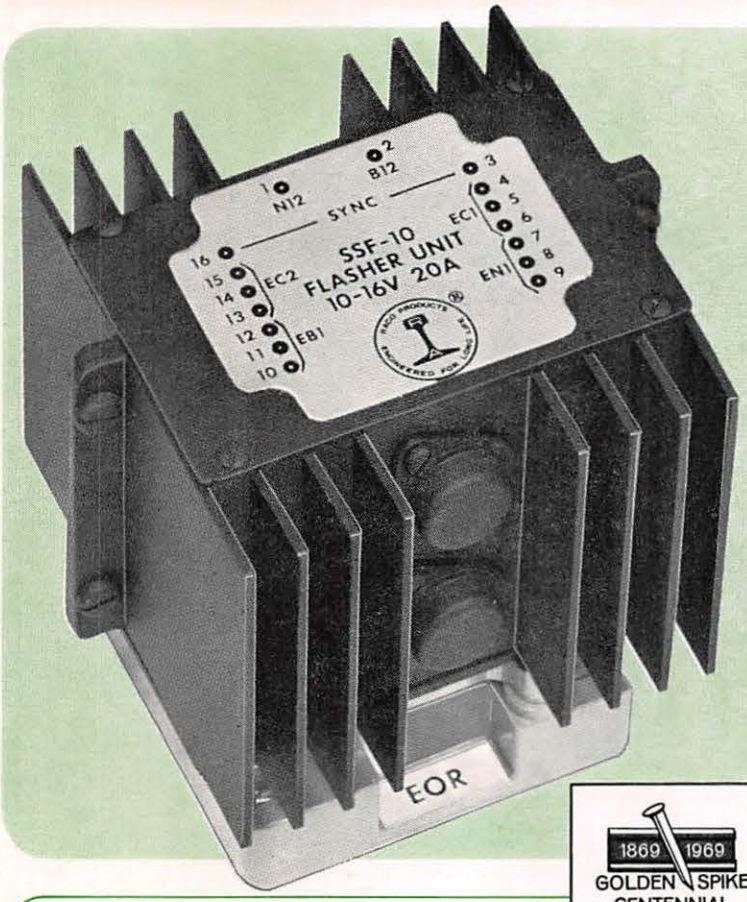

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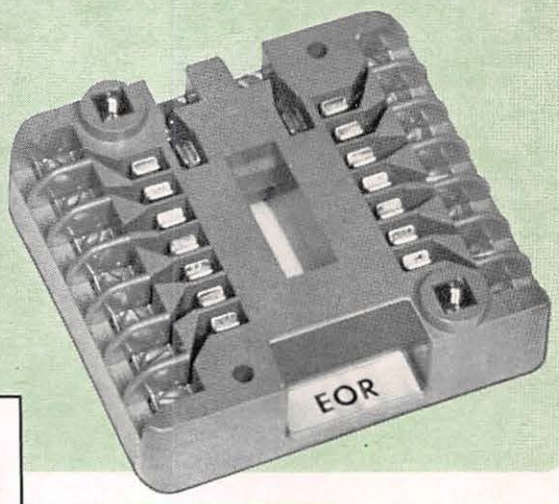

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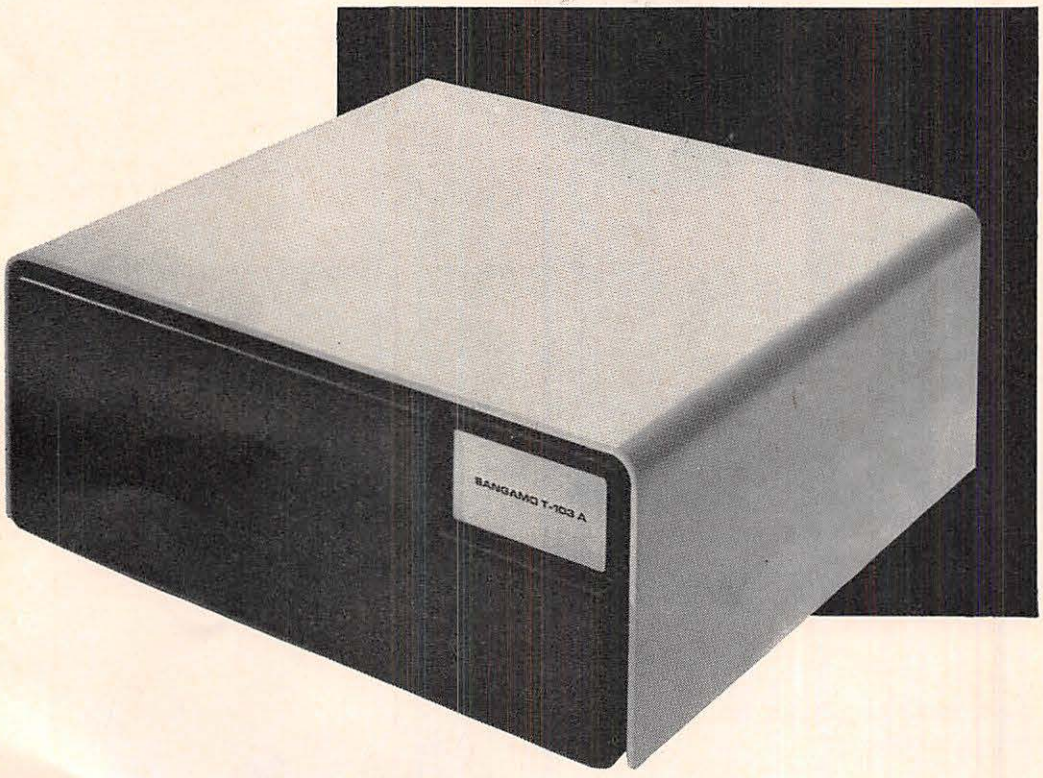

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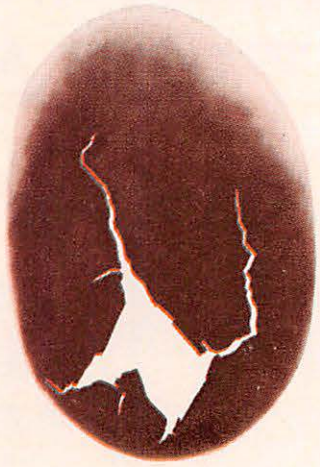

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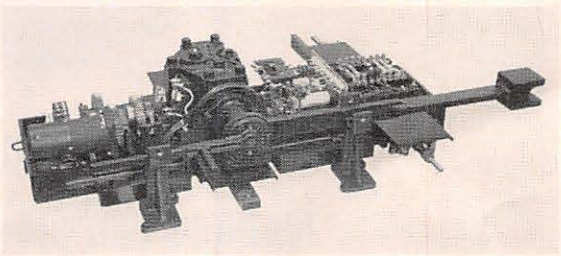

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Editor's Corner

The recent settlement of the signalman's wage case with the nation's railroads is a hopeful sign. Signal engineers should be happy that the men in their departments who do the construction, installation and maintenance work are now recognized as skilled electricians. Admittedly, the hand was somewhat forced, but at last railroad managements must realize that the skilled technicians that keep signals functioning properly and hump yards operating deserve to be recognized and paid commensurate with their skills and responsibilities.

The Presidential Emergency Board based its decisions upon the fact that in the past signalmen and electricians have been treated about the same (RS&C April 1969, page 22). Seems to me a signalman should be paid more than an electrician. He requires more skill. He is a composite mechanic-electrician. He does wiring, sheet metal work and pipe fitting, also a little carpentry, plus testing and trouble shooting. Also, he often works alone with no immediate on-the-job supervision. When this signalman says the signal system is working and safe, dispatchers and operators then direct trains to move.

And what did the signalmen really get from the Emergency Board and negotiations with the nation's railroads? Signalmen, signal maintainers and mechanics received a 22¢ an hour skill adjustment retroactive to July 1, 1968. Assistant signalmen, assistant signal maintainers and helpers received a 9¢ an hour skill adjustment, also retroactive to July 1, 1968. Wages for all classes of signalmen were raised 3½% effective July 1, 1968 (after the skill adjustments apply). Another 2% raise is effective Jan. 1, 1969 and another 3% raise effective July 1, 1969. This will bring a signalman's basic rate to about $3.75-$3.80 per hour.

Sounds great, doesn't it? But let's look at the conditions prevailing, such as the acute shortage of signalmen, the difficulty in attracting new men into signal maintenance work, and the problems in keeping signalmen on the railroads. Everything considered, the signalmen are just about catching up with their newly won raises.

I believe they deserved these raises, and I hope that the signal engineers will realize that well-paid men can be the best security for a well-run and operated signal department. After all, the signal engineer is responsible for his department and the men in it. He can have one with an esprit de corps, teamwork or whatever you call it, and this is what makes for cooperation, and in the last analysis for doing a better job for the railroad.

Bob McKnight

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TTC PROGRESS REPORT:

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The best thing about Total Terminal Control is that the benefits, to both the railroad and its customers, are immediate. Union Pacific's new Bailey Yard at North Platte, Nebraska, is a shining example. The first benefit was the elimination of yard congestion along the line. "Congestion will develop at times," said a U. P. official, "Bailey Yard sure helps relieve that problem."

Seven other switching yards nearby also discovered an effective decongestant in the new North Platte two-way funnel. There are separate eastbound and westbound facilities. The eastbound yard (Bailey Yard) is the new one, and can handle more than 3000 cars a day. Two tracks over the hump lead to 62 tracks in the bowl. Twin hump towers and controls enable two trains to be classified simultaneously, or a single train can be classified from either lead to any bowl track via crossovers. The system provides a complete and instant inventory of every car in the yard. Combined with the companion yard that is now hustling westbound traffic, the new yard results in better control of all car movements, loads and empties, and marked improvement in the handling of both local traffic and long-haul, interline traffic. A process-control computer and a WABCO yard control system maximize Bailey Yard's huge throughput at the lowest possible total cost.

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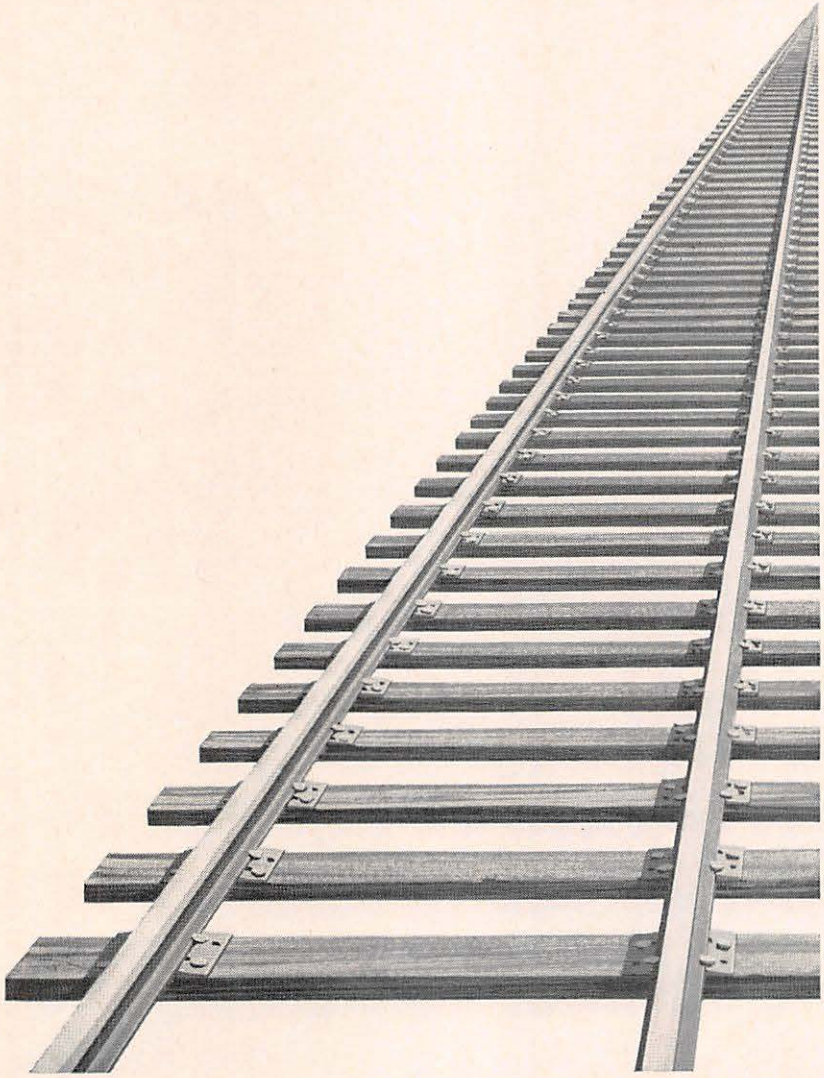
Not with the PMC you don't!



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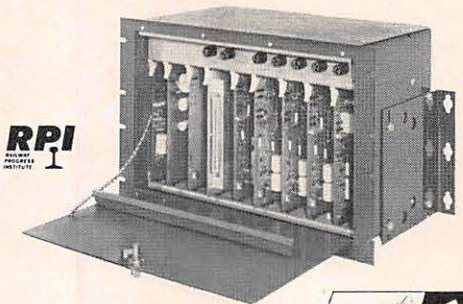

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They had to go through the Cheyenne Pass and they had to go through the Laramie Hills.

And they had to go through the Sioux.

The Sioux had already massacred Fetterman and 81 men outside Fort Phil Kearny.

(Seven years later, they would massacre Custer.)

Now it was the railroad's turn.

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Two things kept the railroad moving: the Indians did not know how to rip up track—and the Winchester arrived.

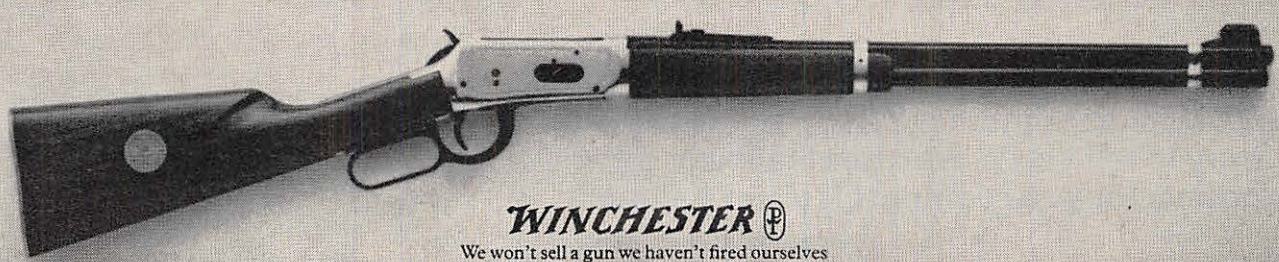
15 shots per man.

100 years ago the golden spike was driven into the ties at Promontory Point, Utah, where the Union Pacific and the Central Pacific met.

We feel it would be appropriate to mark the anniversary with a special, limited edition Winchester—the Golden Spike Commemorative.

With a receiver and barrel bands of plated yellow gold, a commemorative scroll on the breech, and a U.S. Mint-struck medallion in the stock, this beautiful version of our famous "94" will be offered in carbine only.

Its cost will be $119.95.



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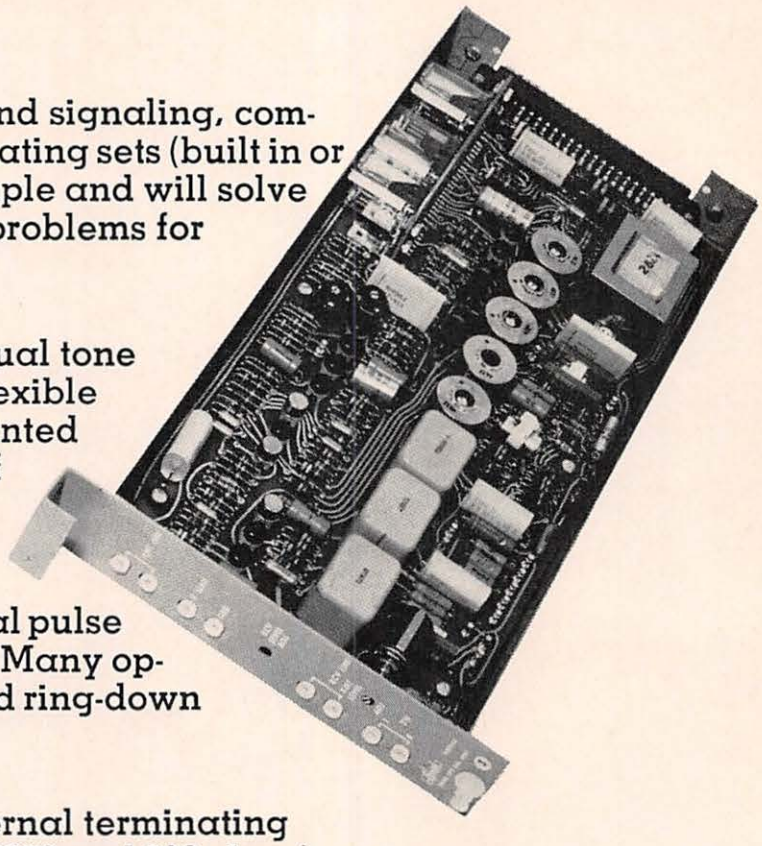

Lynch B850 transistorized inband signaling, combined with Lynch coil type terminating sets (built in or external) make a compatible couple and will solve your signaling and terminating problems for 4-wire/2-wire applications.

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For any communication problem, call your Graybar Communications Specialist. He will be happy to tell you more about these or any other products for your communication system.

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Circle 12 on reader service card on page 38

Good grounding cuts damage

By Norman A. Bolton
Advanced Project Engineer
General Railway Signal Co.

It may seem hard to believe that a whole talk can be given about one terminal, but such is the case when the salient points of "The Prime Ground" terminal are considered. The word "prime" was chosen because it seems to best express the concept of a terminal which really isn't ground but functions as though it were. We tend to think that a piece of apparatus is grounded if it is connected by a wire to something that is buried in the ground. This is because when we run this wire there is usually little current flowing in it and consequently it is actually fairly close to ground potential. However when current does flow to ground, Ohm's Law applies and now the ground wire is no longer at ground potential.

The voltages encountered on the apparatus end of a ground wire can actually be quite high, especially when the current flows in a short pulse or surge. In a surge, the rapid change in current involves the inductance of the ground lead and its inductive reactance must therefore be taken into account.

Furthermore, any metallic connection to ground must of practical necessity be limited in its extent and therefore an additional impedance will be present in the contact with true ground. In general, the larger the ground contact, the lower this impedance will be, but there are limiting factors caused by local conditions. For instance, the ground contact may be buried in soil or sand of poor conductivity; or if in soil of good conductivity, that soil may be insulated from true ground by a peculiar rock formation. In actual value the DC resistances involved in making contact to true ground may range from a few ohms to a few hundred ohms and the impedance to a fast rising surge will be even greater.

The other factor influencing the voltage rise of the ground wire during a surge is the current that flows during the surge. The peak currents in lightning strokes range from 4,000 to about 220,000 amperes with the majority of strokes being about 40 to 100 thousand amperes. This current is discharged in a single surge in most cases but sometimes cloud-to-cloud discharges occur following the initial stroke and successive strokes will follow the path ionized by the first. These surges build up rapidly, reaching their peak current in one or two millionths of a second (one or two microseconds). The current then tapers off to about half its peak value in 20 to 40 microseconds. These values are for direct strokes and in railroad signaling this is generally charged off to "an act of God" because direct strokes do not make up a very great percentage of the outages compared to the number caused by surges induced indirectly into railroad signaling circuits.

When a highly charged cloud capable of producing lightning strokes is blown by the storm over railroad property, electrical charges from the earth are attracted from the ground with

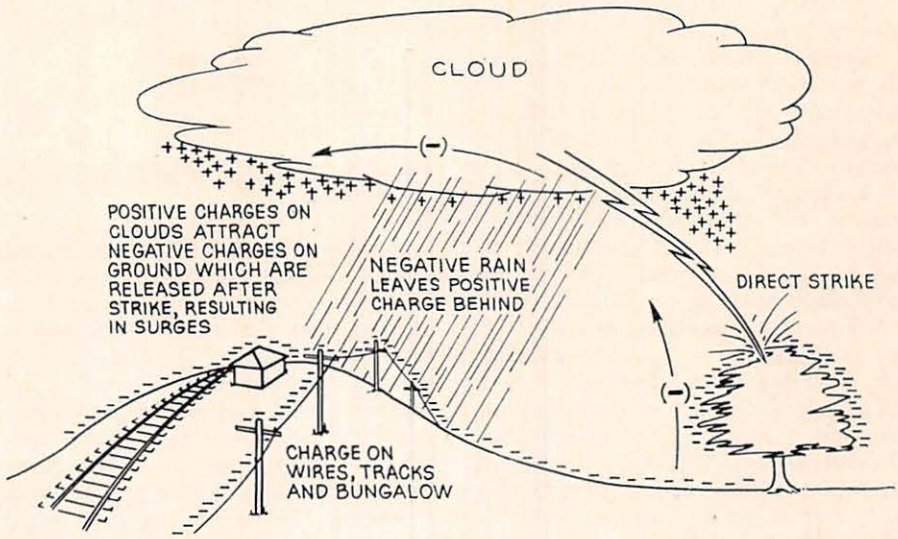
CLOUD
(−)
POSITIVE CHARGES ON CLOUDS ATTRACT NEGATIVE CHARGES ON GROUND WHICH ARE RELEASED AFTER STRIKE, RESULTING IN SURGES
NEGATIVE RAIN LEAVES POSITIVE CHARGE BEHIND
DIRECT STRIKE
(−)
CHARGE ON WIRES, TRACKS AND BUNGALOW

Figure 1: Source of most surges are thunder storms.

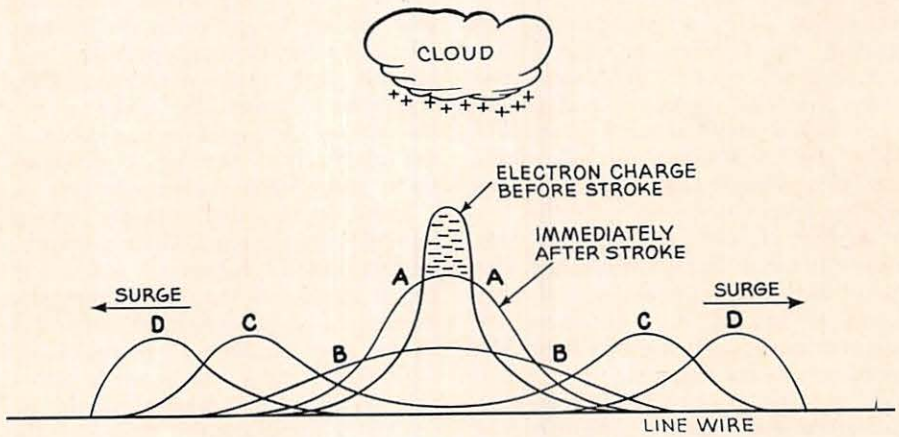

Figure 2: Drawing showing surge development after cloud discharge. *

Editor's Note: This is an abstract of a paper presented at the Western Sectional Meeting of the Communication & Signal Section, AAR, held April 15, 1969 in Omaha, Neb.

opposite polarity but with equal quantity to a spot on the surface of the earth directly beneath the charged cloud. These charges may accumulate in the rails, line wires, apparatus housings, or on any exposed surface. Figure 1 illustrates the fact that if the cloud is discharged to earth at some distant point, even miles away, these charges which have accumulated slowly are instantaneously released.

Figure 2 shows how this instantaneous release creates surges in conductors such as rails and line wires which can cause heavy damage.

The exact magnitude of these surges is not easily measured but has been estimated to be up to 1/10th the magnitude of the stroke itself under certain favorable circumstances. Thus it is apparent that although a target of only a few square feet is subject to a direct stroke, all the locations in the whole thunderstorm area are subject to this indirect source of surges.

Since surges produced in a line wire or rail travel in both directions along the conductor when released, it is likely that only half the current would be available to enter any given apparatus location or one twentieth of the current in the total stroke. The currents that may therefore be expected in the ground lead at a location, range from 200 to 11,000 amperes with the majority being under 5,000 amperes. If 3,000 amperes is selected as a typical value and the surge impedance of the ground lead is taken at 100 ohms (a conservative value), Ohm's law indicates that the apparatus end of the ground lead would attain a potential of 3,000 x 100 or 300,000 volts. Obviously, this ground lead cannot be depended upon to remain at ground potential.

At first glance this seems an intolerable situation but all is not lost. The factor that causes breakdown of insulation in equipment or the overloading of transistorized circuitry is not the absolute potential to which it is raised during a surge but the difference in potentials of the various components of the circuit at that time. If all points of the circuit rise in potential at the same rate to the same level, no difference in potential can exist and therefore nothing can be damaged. It is like two men riding up in an elevator together. They can shake hands or converse at will, but this is not so if one of them remains behind on the ground floor.

The problem of lightning protection therefore becomes one of getting all components of a circuit to rise in potential together during a surge. This is where the prime ground terminal comes in. The prime ground terminal is a single terminal to which all components of a location must be connected. To this terminal should be connected the ground leads to the buried ground contact, the heavy conductors from the lightning arresters on the incoming wires, the chassis of the equipment in the housing, the housing itself and the arresters from the rails. The terminal serves as a sort of interchange point and, regardless of which component a surge arrives on, it can leave the location through the path of least resistance. For instance, if the ground contact at the particular location is not good, the surge may prefer to break down the gap of the rail arresters and use the rails as the means of reaching true ground. In any event the terminal assumes some elevated potential and, because of the interconnections, all the apparatus assumes the same potential and no harm is done. Actually it is not practical to attempt to place all these heavy wires on a single post, so a small group of compactly spaced terminals may be used. These should be interconnected, however, with very heavy straps so that no appreciable differences of potential can occur between them. A 4" x 4" piece of ⅛" thick copper stock can be made into a plate for connecting these terminals.

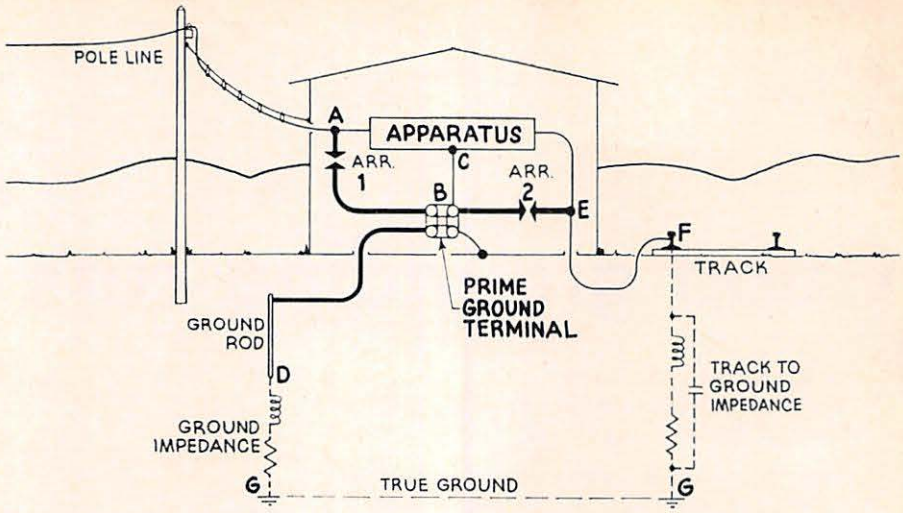

Figure 3: Connection of apparatus and arresters to prime ground terminal.

This is therefore the utility of the prime ground terminal: it functions as though it were grounded even though it may rise in potential during a surge discharge to many thousands of volts.

Figure 3 is an arrangement showing the connection of apparatus and arresters to the prime ground terminal in an equipment housing. For purposes of illustration the connections are kept very simple with only one line wire and one track lead.

The prime ground terminal shown as four strapped terminals can be seen to be the central interchange point of any surge regardless of its source or destination. Assume for this illustration that a large surge arrives along the line wire. Without the arrresters shown and with no connection to the prime ground terminal, it might easily destroy the apparatus as it seeks the best path to ground at the rails. The arresters will allow only a slight rise in voltage before they ionize and provide a low impedance path to the prime ground terminal. At all times the current which will flow to the apparatus is a function of the impedance of the input circuit and the voltage applied. Therefore the impedance of the apparatus input circuit should be as high as possible so that little current flows before the arrester breaks down. After breakdown the current will divide at point A and the voltage available to force current into the apparatus will be the drop across the arrester and its ground lead. This dictates that the arrester should have little resistance once ionized and the lead connecting it to ground should be as short and heavy as possible—within practical limits. By way of illustration, assume that the apparatus were not correctly connected to the prime ground terminal as shown by wire CB, but instead, point C were wired out to a separate ground. The voltage in this case available to force current into the apparatus would include the arrester ionization voltage, the drop between the arrester and the prime ground (A-B), the drop in the lead to the ground rod (B-D) and the drop across the ground impedance (D-G). And we found out in a preceding paragraph that this latter drop might well be 300,000 volts. Another way of looking at the action of the prime ground terminal is to realize that wire CB applies to the chassis and common circuits of the apparatus, the potential to which the prime ground terminal rises during surge discharge and thus equalizes the difference in potential across the input to the apparatus. From this point of view another good name for the prime ground

terminal would be equalizing terminal.

Assume now that the surge arriving on the line wire, in passing through the ground impedance, raises the potential of the prime ground terminal above the breakdown voltage of arrester 2. Point E is connected to the rails which may be excellent grounds, because they are such good conductors and are intimately associated with the ground over such a large area. With ground on one side of arrester 2, and a potential above breakdown on the other, arrester 2 ionizes and current from the line now flows out the track leads to the rails (E-F) and thence to ground (F-G). During this current flow the voltage drops (E-F and F-G) combine to raise the potential of point E toward that of the prime ground terminal. If the drop in arrester 2 and the lead connecting it to the prime ground terminal is negligible, the output lead of the apparatus will assume the potential of the prime ground terminal and thus be protected also, the apparatus never being subjected to a difference of potential at its output exceeding the breakdown voltage of the arrester.

Thus the prime ground terminal protects the apparatus by equalizing the potentials of all its members and allowing the surge access to any path to ground through arresters which can handle the current involved, rather than through the apparatus itself which cannot. It can also be seen that the true function of the arrester is to bypass the surge currents, and arresters should be considered in that light.

HEAVY CURRENT FLOW

When getting down to the quantitative consideration of these ground leads and where they are run, bear in mind that heavy currents flow in these wires (the ones shown in heavy lines in Figure 3) and these wires should be kept well away from all other wiring, preferably along the bottom of the equipment housing.

A wire of AWG #2 size can be used for some connections, for others perhaps a #6 size would be more practical. However, it should be as heavy and short as possible because the only alternative is to increase the impedance of the apparatus branch, which is usually expensive compared to the value of copper by the pound.

It should be noted at this point that lightning protection is one of those statistical, relative things; that is, for any degree of protection there will always sometime be a transient that results in damage to the equipment. Nevertheless, a degree of protection can be reached where these occurrences becomes so infrequent they cease to be a major irritation. This should be kept in mind when designing a lightning protection circuit. The difference between a #2 and #6 wire or a location of an arrester that cuts the circuit length down six inches might make the difference between survival and destruction of equipment; indeed it will make the difference sometime, at some location.

Lightning by its nature is generated as a high voltage charge with respect to ground potential. It follows then that during a discharge it is seeking to close the path to ground to return to an equalized state. Railroad equipment, however, is often in the path of this discharge and cannot help but become a portion of it. Previous paragraphs showed how lightning could be bypassed around electronic apparatus to the prime ground terminal, but now it must be passed on to true ground in a manner that is reliable, prevents damage to equipment, and is as safe as possible for people working with the equipment.

When lightning strikes the shore of a lake or ocean, it sometimes fuses the sand into what is known as a "fulgurite" which resembles the roots of a tree. About an inch or two in diameter, it descends into the sand, branching in all directions into smaller and smaller tubular extensions. This illustrates that the natural tendency for lightning upon entering the ground is to spread out in all directions, and so a ground connection to be useful should be patterned in ths same manner, within practical limitations, of course. The ground connection must also conduct the surge safely away from the vicinity of the equipment housing and its buried cables.

The ground connection consists basically of two parts, the portion buried beneath the soil of the earth which can be called the ground contact and the portion which connects the ground contact to the prime ground terminal which can be called the ground lead.

The ground contact ideally should be a very large heavy mass of metal in contact with the soil beneath the equipment housing. It should be made of a material which is highly conductive and should be constructed to have as large a surface area as possible. The material should also be capable of maintaining an intimate contact with the soil without rusting, corroding, or losing contact over the years. This material should be buried deeply to reach soil which is permanently damp and not capable of drying out during the hot summer months. Two further requirements of the ground contact is that it be economical and easy to install.

The most popular form of ground contact has, over the years, proven to be the ground rod, and rightly so since it fulfills the requirements, quite well in areas where it can be used. It is economical and can be installed merely by driving it into the soil. It can be made of copper which is highly conductive and will not corrode unless in the presence of salts. For greater strength when driving the rod, steel can be used but it has neither the conductivity nor corrosion resistance of copper and must be galvanized or lead coated to be of value. There is a happy combination of these materials however which is steel rod coated with a heavy jacket of copper. It has good strength for driving, good conductivity, and good corrosion resistance.

BURIED PIPELINES

Another form of ground contact which is both effective and economical is to use buried pipelines when they are available. Lines such as water mains are quite extensive and their conductivity usually is high enough to provide an effective ground contact. Certain precautions must be taken here, however, to be sure there are no insulated sections in the pipe. Water meters, for instance, sometimes are equipped with nonconductive gaskets so they should be bypassed with a short heavy lead connected to the pipes on both sides. These are usually not available for railroad use, however, except occasionally at office or station locations. Similar to this type of ground are ground contacts made by a well casing or the foundational piers of some buildings.

Assuming that a pipe ground is not available and ground rods are elected as the most practicable means of obtaining a gound contact, the problems arise as to how many rods, how long, and where are they placed? Volumes have been written on these factors because the conditions under which they are used vary to such an extent. Soils vary in conductivity according to their composition and moisture content and some locations have stratified soil—where soil of good conductivity may be covered by a layer of soil of poor conductivity. Sometimes too, a layer of poor conductivity will be so situated that it insulates an area of good conductivity above it from true earth ground. A ground contact varies also depending upon its application. For instance, if the ground contact must occasionally handle large amounts of AC power such as would flow if a transmission system were shorted to ground, it must have a large enough area to allow the current density on its surface to be low enough to prevent local heating which would dry out the moisture from soil at the point

of contact. Also some ground contacts must be able to withstand the energy of perhaps several lightning strokes in succession.

As to the length and diameter of the ground rods, Figure 4 shows only marginal decrease in ground resistance as the rod increases in diameter and very little decrease as the rod gets longer than 8 to 12 ft.

For this reason a minimum rod diameter of sufficient strength to withstand driving is chosen (⅝" to ¾") and the length may be anywhere from 8 to 10 ft. The graph in Figure 4 is for rods driven into soil of average resistivity (° = 100 meter-ohms). From it one can read that one rod 10 ft. in length and about ⅝" in diameter would have a theoretical resistance in this soil of 40 ohms to true earth ground. Therefore two rods if far enough apart would have a resistance of 20 ohms and four rods a resistance of 10 ohms. These may be considered typical values. If the railroad desires, because of poor local conditions, to increase the ground contact, longer rods may be used, or the trenches extended outward from each corner another 10 to 12 ft, and another ground rod driven. Sometimes a lead can be extended to a nearby pond, stream or pool and a rod buried there. This may help some but is probably not too beneficial if the lead is very long.

If it is desired to compute the theoretical ground resistance of some other structure such as a well casing or steel foundation, the following formula will serve as a guide:

R = Ground resistance in ohms
ρ = Soil resistance in meter-ohms
l = Length of ground structure in centimeters
D = Diameter of ground structure in centimeters

$$R = \frac{100\ \rho \log \frac{41}{D}}{2\ \pi\ l}$$

Where, because of the nature of the soil (stony or solid rock), ground rods cannot be driven, shallow radial trenches may be dug from each corner of the bungalow and ground rods laid horizontally in them. Also a heavy wire may be run out in these trenches (#6 or #2), and coke buried around the wire may help by extending the effective diameter of the wire. When this is not possible, wires can be run out radially from each corner and cemented to the face of solid stone with concrete. These may have to extend 50 to 100 ft to be effective. If one of these wires reaches soil where a rod can be driven, it should be, and the wire terminated at the rod. A ground resistance (which can be measured with several forms of commercially available instruments) of 5 to 10 ohms is generally thought to be adequate. In some cases this may not be reached but if the prime gound terminal concept is used, protection may nevertheless be adequate. After all, even 5 ohms is a lot when thousands of amperes of a surge are flowing. It would seem practical to adopt a protection scheme such as shown in Figure 5 for use as a standard and then upgrade the protection from this minimum where, when, and if experience so dictates.

In general however, a typical installation can be described which will provide adequate ground contact for the typical location. Such a location might be as described in Figure 5, which shows a small instrument case and a bungalow. Note that two rods are shown for the instrument case and four for the bungalow.

NOTE 1: Connections to ground rods may be made above ground level if desired for purposes of inspection, but it is not necessary to do so for purposes of disconnecting for test. If rods may be made above ground level the ground network is installed as shown and used in connection with proper prime ground terminal connections, it will be adequate for all practical purposes and need not be checked for conformance with any arbitrary value of ground resistance. A properly built and installed ground network should not require frequent checks.

NOTE 2: Treatment of the soil around ground rods with salt or other chemicals is not recommended because of the probability of corroding the copper and its connections.

NOTE 3: If, because of soil conditions, ground rods cannot be buried, lay them horizontally in trenches extending radially from all four corners of the case or bungalow. If trenches cannot be dug, cement to the face of the rock, #2 bare copper wire extending radially from the four corners for 50 to 100 ft. If these wires reach points where a rod may be buried or driven do so and terminate the run.

One might think that if two rods were adequate for the case they would also be adequate for the bungalow. There are other factors which indicate the need for four rods at the bungalow, however. When a ground rod is driven into the soil, the soil surrounding the rod itself becomes conductive. extending the surface area outward from the rod in a radius of 6 to 10 ft. If another rod is now installed within this conductive area it will only reduce the resistance to ground to the extent that the circles do not overlap. Figure 6a shows two rods just a foot apart. These two rods are just slightly more effective than a single one would have been.

Figure 6c shows the two rods 12 ft. apart with their circles wholly apart; in this case nothing is lost and the two rods have half the ground contact resistance of a single rod. Figure 6b shows the two rods 6 ft apart with their circles, overlapping. The shaded areas in this figure indicate the relative ground contact improvements by the second rod, therefore, it can be seen that the benefit gained by the second rod is seriously reduced when the rods are spaced closer than 6 ft. For this reason, in Figure 5, four rods are not shown surrounding the instrument case; an additional two rods would not pay their way because they would be so close to the other two. On the bungalow, however, they are effective because of its greater size.

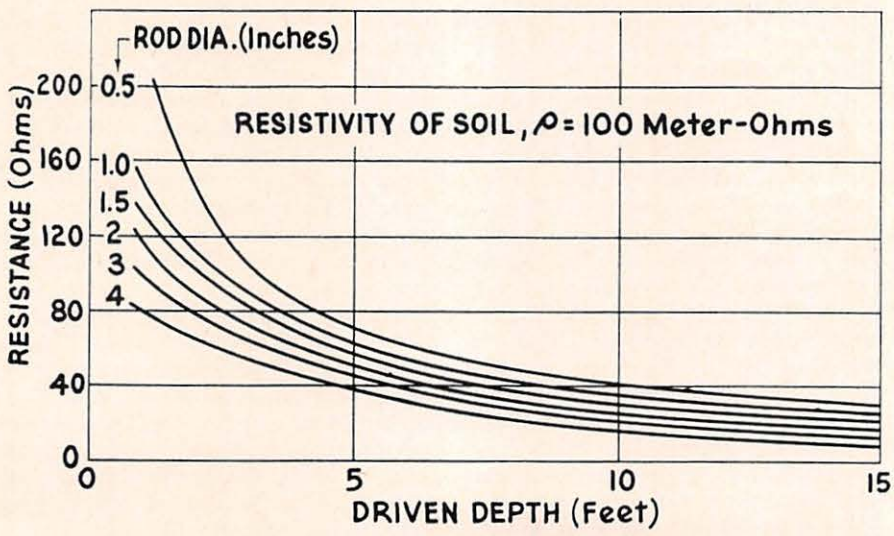

Figure 4: Curves shows resistance of ground rods vary with depth driven.

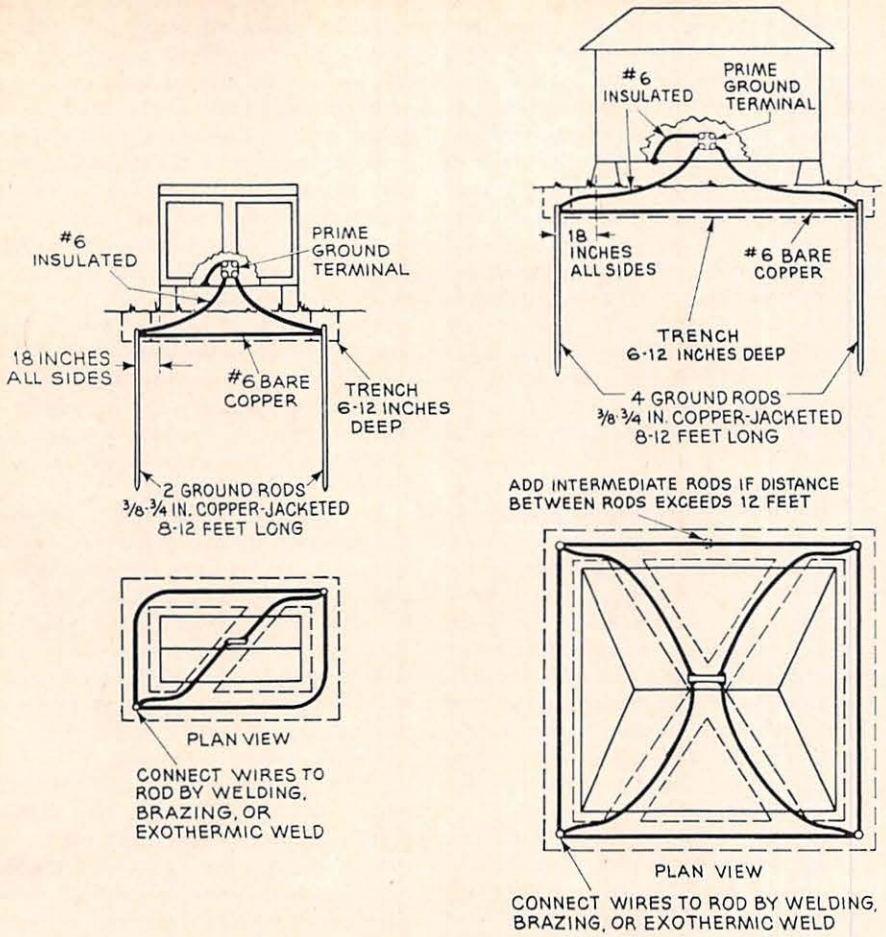
#6 INSULATED
PRIME GROUND TERMINAL
18 INCHES ALL SIDES
#6 BARE COPPER
TRENCH 6-12 INCHES DEEP
2 GROUND RODS 3/8-3/4 IN. COPPER-JACKETED 8-12 FEET LONG
PLAN VIEW
CONNECT WIRES TO ROD BY WELDING, BRAZING, OR EXOTHERMIC WELD
#6 INSULATED
PRIME GROUND TERMINAL
18 INCHES ALL SIDES
#6 BARE COPPER
TRENCH 6-12 INCHES DEEP
4 GROUND RODS 3/8-3/4 IN. COPPER-JACKETED 8-12 FEET LONG
ADD INTERMEDIATE RODS IF DISTANCE BETWEEN RODS EXCEEDS 12 FEET
PLAN VIEW
CONNECT WIRES TO ROD BY WELDING, BRAZING, OR EXOTHERMIC WELD

Figure 5: Drawings of suggested typical ground connections.

The bungalow is provided with a ground rod at each corner so that if the lightning wants to spread in all directions at once it can, for it will find a low resistance path at each corner. If, for instance, a rod or two rods had been provided at the north side of the bungalow but the lightning found something in the ground such as a pipe or water deposit to the south more attractive it might well ignore the rods on the north side and go directly to the south either through the air, along the surface, or through some buried cable, causing a good bit of damage.

The second part of the ground connection, the ground leads, must be installed to transfer the surge from the prime ground terminal to the ground contact, smoothly, safely and with very little impedance. Again, keeping in mind how the surge would travel naturally if unrestrained, the ground leads should be installed to run generally downward and outward. The prime ground terminal should be centrally located in the housing, if possible, and the ground rods located just outside the corners of the housing. If this is done the ground leads can be dropped straight down through the access hole and then curve gradually outward to the corners. One ground lead should run directly from the prime ground terminal to each corner ground rod. Sharp bends should be avoided in these leads because they are like partial turns on a coil and the self-inductance of these partial turns unduly increases the impedance of the ground lead, which is definitely not desirable. Generally, bends of eight-inch radius or more are allowable but tighter bends than this should be avoided. If, in a particular housing, no access hole is available beneath the prime ground terminal, and no hole can be made without extreme difficulty, the ground lead may be dressed across the floor of the housing to an available outlet and then leave through there with suitable gradual bends. However, it is very desirable to locate the prime ground terminal very close to the access hole in the bottom of the housing, and this should be done if at all possible. A hole in the housing separate from other wires is not necessary if these wires are entering the housing and running directly to arresters, but if this is not the case, these other wires should be kept well away from the ground lead and grounded parts of the housing to prevent the breakdown of the insulation of these wires. Ground leads should also be kept away from incoming cables to prevent insulation puncture beneath the ground surface. Figure 5 shows the ground leads run in an "X" trench beneath a bungalow; incoming cables can be run, in this case, from the sides of the bungalow and they will therefore not approach the ground leads until just before they reach their arresters, which is acceptable.

While on the subject of bends in cables a word about the burying of underground cable may not be amiss. Some railroads have a practice of coiling excess lengths of incoming cable in a pit beneath or adjacent to the housing. While there may be good practical reasons for this it should be remembered that these loops create a coil because of their inductance and that surges are of a very high frequency. Surges traveling in these cables will therefore create high voltages across these turns which the cable insulation may not be able to withstand. The resulting breakdown, if it does not cause outright destruction in the cable, will cause pinholes to develop which in turn may allow water to enter the cable and degrade its insulation, and even cause eventual conductor failure through the electrolytic corrosion of the copper itself.

When a surge is traveling down one conductor of a cable it tends to have a high potential at the particular place where it is at any given time. Normally, these potentials could break down the insulation of the conductor and a short might occur to an adjacent conductor. There is, however, a self-protecting fea-

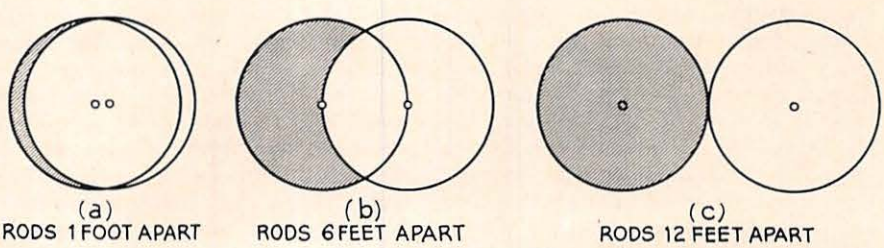

Figure 6: Spacing of ground rods can be most important.

ture to this action. The high potential is accompanied by high currents and these currents induce currents in the other wires of the cable. These currents thus produce high potentials in the other conductor which equalize the between-conductor potential difference and prevent breakdown between the conductors. This action occurs only when the conductors are close together, as in a single cable. From this it can be seen that it is highly advantageous, when running wires in a ditch, to keep them running parallel and in close contact. It would be well to tape or otherwise spiral-wrap loose conductors traveling in the same ditch, to the same location, into a good tight cable before filling the trench. Rope, or cord, or even one of the conductors could be used for this. Cables to different locations would be better off if separated along their lengths as far as possible with six inches to a foot being an approximate minimum depending upon the length of the runs. This is because insulation breadowns are liable to occur where one conductor enters, or pulls out of, the influence of another surge-carrying conductor.

Figure 5 shows a trench around the outline of the case and bungalow and a bare copper wire connecting all the ground rods. There are actually four reasons for this interconnection wire which justify the cost of installing it. The trench does not have to be deep, six inches is enough and even less would suffice if digging is difficult. One reason for this wire is the protection of personnel from the hazards of electrocution if in contact with the ground and the housing when a surge occurs or if the ground leads are conducting considerable amounts of AC power. The likelihood of a person touching the housing at the time when a surge occurs is admittedly not great but nevertheless it is possible. The times when protection is more often needed is when AC power is being conducted to ground, because the drop between the ground contact and true earth potential appears as a potential above ground at the housing. Many railroaders are familiar with the uncomfortable tingle which is sometimes experienced when entering a bungalow, especially where heavy AC power lines are nearby, and on wet or damp days. Protection from this is obtained because this wire raises the potential of the soil in the immediate vicinity of the bungalow, during these discharges, to that of the ground contact and thus equalizes the voltage differences between the housing and the earth beneath it.

Another purpose of the interconnecting wire is to furnish current from the ground leads of adjacent ground rods to a particularly well situated rod which, by reason of a soil or underground irregularity, is in better contact with the true earth potential. This allows the effective paralleling of the two or four ground leads and a consequent reduction in the rise of the prime ground terminal during a surge.

Another purpose of the interconnecting wire is that it furnishes redundant connections which will keep the ground connection in operating condition longer in the event of physical damage or corrosion of its copper parts.

Finally, it is of benefit itself in making contact with the true earth potential. Since it is conductive, it acts on the surrounding soil to a large extent in the same way as would a copper plate of the same dimensions in making contact with the soil below.

In making connections between ground rods, ground leads and the interconnecting wires, a process employing an exothermic reaction appears to be the most generally satisfactory. However, a skilled welder can braze very acceptable connections with care. When brazing wires to a ground rod, the wires may first be fastened to the rod with a few wrappings of heavy, solid, bare copper wire and then the whole connection brazed into a solid uniform mass. It would be well to coat the whole connection, after any flux used has been removed, with a waterproof compound to prevent corrosion at the points of connection.

GOLDEN SPIKE ANNIVERSARY:

Controls expand in next century

Back in 1869 telegraph was the one means of fast communications. The agent-telegrapher, no matter how far out along the line, could be in contact with headquarters, the division offices and usually the dispatcher. Telegraph did a fine job then. And it does now, although by using a typewriter keyboard, messages can be sent much faster than using the old key and sounder method.

Railroads have progressed much in the 100 years since the nation was linked by rails on that May 10, 1869. One of the signs of the years of progress is the digital computer. In the 100 years since the Golden Spike was driven, that agent-telegrapher (now he may be an agent or agent-operator) has the means to communicate with the computer. He can now have literally the entire railroad at his finger tips. The vast storage capacity plus the almost instantaneous information retrieval capabilities of the computer enable this agent out on the line to get almost any information he needs or wants.

With only the telegraph, the agent was really an order taker. He took orders from customers and from headquarters,—dispatchers and superintendents. Now he is a manager. At his grasp via today's tremendous communications capability, he can get the facts from which to intelligently manage his area of activity.

The next 100 years of railroading will truly be a revolution in the way things get done, how railroads operate, what people can do, etc. The tools of this managerial revolution are here, right now in 1969. Yes, there will be some breakthroughs and undoubtedly some startling developments. But the basic tools are here. Computers will no doubt increase in capacity to calculate, compare, sort, tabulate and correlate data. And with the increase in calculating ability will come a similar marked increase in storage capacity and a considerable shortening of time required to calculate and retrieve information. Techniques in miniaturization will make it possible for the truly desk-size computer to become a standard device for a manager's office.

And communications links will be expanded in capacity and speed so that from the desk-size computer to the large scale mammoth in the general office, there can be direct links. Computer-to-computer communications will be commonplace. Also, the man-to-machine links will be greatly expanded.

Railroad managers at all levels—from the agent or supervisor along the line to the supervisor or department head in the general office—will be better able to manage because of the computer communications links including the man-machine links drawing all

(Please turn to page 20)

For people who missed it the first time, KarTrak helps do it again.

In 1869, it was the old silver-maul/golden-spike routine. The last tap closed a telegraph circuit to tell the world about the event.

Today, it's only an act.

Because this time, the real signal about the Promontory Summit meeting comes from railroading's newest technology, the KarTrak* ACI system.

We put KarTrak labels on each of the engines. And set up a trackside scanner to generate the signal that sends the news around the world.

It's more than just a gimmick, though. We're helping tell a powerful story.

By the end of the year, the entire freight car fleet will wear KarTrak labels. But they won't do you much good unless you have the complete KarTrak ACI system to keep track of the cars.

It's going to make your second century coast to coast a whole lot easier.

Sylvania Information Systems, Commercial Electronics Div., 100 First Ave., Waltham, Mass. 02154.

SYLVANIA
GENERAL TELEPHONE & ELECTRONICS

*Trademark

Photo: The Bettmann Archive, Inc.

GOLDEN SPIKE

(Continued from page 18)

together into a unified whole.

Railroads are now well along the road toward unified control of their operations. Consider the communications area. While several railroads have system-wide microwave networks, there are others just starting to install this bulk communications facility. Communications between railroads must be as easily obtainable as freight cars are to move from one road to another.

Communications usage in the next 100 years will border on the truly fantastic. For man-to-man, there will be the telephone and radio for voice communications. But these will be supplemented by various types of graphic systems enabling a man in his office to write or draw pictures for his listener on the other end of the line. Data transmission will include today's techniques with refinements which will make the terminal equipment smaller, easier to maintain and more reliable.

For the bulk communications facilities required for man-to-man, man-to-computer and computer-to-computer contact, microwave is the present-day work horse. However, cable communications is to the point of economic justification in many areas. Because cable can be buried along the right-of-way, it is immune to weather and electrical disturbances of high-voltage power lines. In congested metropolitan areas cable communications might well be the answer—it does not use spectrum space which requires Federal Communications Commission licensing. Also, cable communications is now technically able to provide the circuit capacity of microwave.

Whether it be basic communications equipment or improved coding techniques, bandwidth compression, etc., one thing is clear, technology will provide the railroads with all the communications facilities they will require, now and for the next 100 years.

This tremendous communications capability will enable the railroads to have true centralized control at their headquarters. Even now, railroads can have operations control centers, and some do. The extensive use of visual displays, plus on-line, real-time computing back up for information processing and retrieval make such a control center possible. Train movement data could be supplied by automatic car identification scanners at strategic locations, plus readouts from centralized traffic control machines.

In addition to such control centers, some railroads will find it advantageous to have a top management "chart room" or visual display center. Here, in all forms of graphic displays would be "the big picture" for top management. Equipment would include motion picture projectors, closed circuit TV screens and controls, video tape recording equipment, cathode ray tube displays, charts, graphs, various intercom devices, pushbutton telephones, etc. Many of these devices would be connected to computers to provide instant information retrieval to provide temporary viewing, or with reproduction equipment to provide a printed copy of the information. Communications would also be provided to various field offices of the railroad to enable top management officers to speak directly with field managers. Provision would be made for talking, writing or drawing between the headquarters chart room and the offices out along the line.

Letters to the Editor

Dear Editor:

In reading the article on Grade Crossing Safety entitled "Crossing Safety Improves," I note a typographical error in the middle column on page 21 [March 1969 issue of Railway Signaling & Communications].

Decision No. 72225 of the Public Utilities Commission of the State of California ordered the use of $30 per AAR Signal Manual Part 203 unit.

The article states $38 per unit. While we would be glad to have the $38 figure, I believe the record should reflect the value established by the Commission.

J. W. Gavey, Chairman, Committee "D" Communication & Signal Section, AAR

Dear Sir:

Thank you for bringing this error to my attention. My apologies to you for any embarrassment it may have caused.

Bob McKnight

Dear Editor:

No doubt you have touched on this before, but I would appreciate your comments on the subject of "where does the signal and/or communications department belong?" On my road they are combined and report to the chief engineer, but I find myself leaning toward two separate and distinct department types of organization, reporting to the vice-president of operations. A free lunch is riding on your replay.

Name Withheld on Request

Dear Sir:

After you read my answer, I may have to buy that lunch. But here goes. I can agree that signals and communications should be separate departments. Both are really service organizations, but signals has a smaller group of customers to serve, mainly engineering and operating. Because signals use the tracks, the wayside, and are closely linked with the track structure, they are usually part of the engineering department organization. And certainly, there has to be close cooperation among signal maintenance and track maintenance forces.

As for communications, this organization serves the entire railroad. Every department uses some form of electrical communications. A few railroads have combined communications and data processing into an information services department. The merit to this type of organization is that one group is responsible for the collection, processing and distribution of information. True, there is the problem of providing communications facilities that are not tied into the computer function, such as local telephone systems, radio, etc.

Some roads have been successful with a combined signal-communications department. But even here, the combination is often the administrative head at the general office or at the regional headquarters. Yes, some have combined S&C supervisors, but often you will find the man is actually trained in one field or the other. Both signaling and communications technology are advancing so rapidly that it is difficult for one man to be really knowledgeable in both fields. There are exceptions, of course. A good administrator can have a good general knowledge in both areas, but he must be supported by specialists.

To me, it seems logical for signals to report to the vice-president operations. Communications should really report to the president or his immediate second-in command, such as an executive vice-president. Communications plays an important role in the work of the marketing and sales, research, mechanical, traffic and executive departments, among others. Reporting to the chief engineer, for example, can give the communications officer a protocol problem. When the vice-president traffic or the executive vice-president "orders" a communications system or equipment (not on the approved engineering budget) a difficult" situation could arise.

It is a case of working with people, often on an informal basis. And this can be a problem, because railroads are much like a military organization. So, the captain doesn't talk informally about company business with the general without the major's permission, etc.) Maybe, that's why I never got to be more than a corporal, but that's something else.)

To get back to your questions. I would say that signals and communications should be in separate departments. The signal engineer would report to the vice-president of operations, and the chief communications officer would report to an executive vice-president, or the president. Communications, because of its broad, company-wide operations should be able to have the attention, respect and cooperation of the corporate officer responsible for overall operations.

I guess that lunch is on me. I do thank you for writing.

Bob McKnight

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Circle 14 on reader service card on page 38

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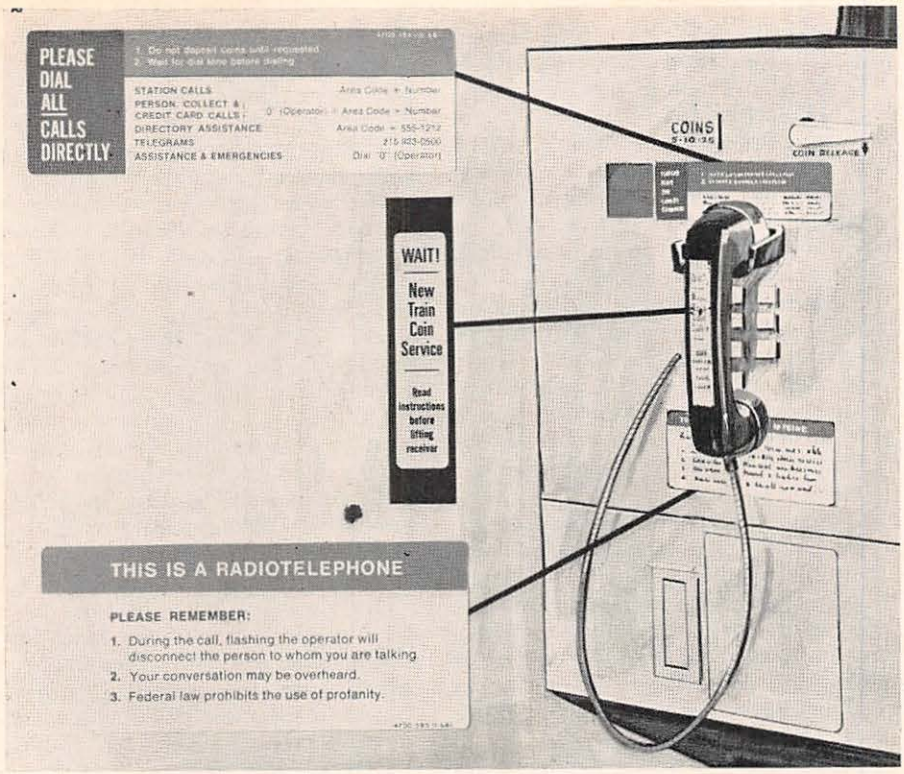

PLEASE DIAL ALL CALLS DIRECTLY
STATION CALLS
PERSON, COLLECT & CREDIT CARD CALLS
DIRECTORY ASSISTANCE
TELEGRAMS
ASSISTANCE & EMERGENCIES
COINS
WAIT!
New Train Coin Service
Read instructions before lifting receiver
THIS IS A RADIOTELEPHONE
PLEASE REMEMBER:
1. During the call, flashing the operator will disconnect the person to whom you are talking.
2. Your conversation may be overheard.
3. Federal law prohibits the use of profanity.

Metroliner phones are Touch-Tone with single coin slot.

Train phones are here

By Fred Ingold
Marketing Supervisor
American Telephone & Telegraph Co.

On January 16, 1969, the "Fastest Phone in the East" took to the rails between New York and Washington, D.C. on the Penn Central's "Metroliner". Although this round trip run was preceded on January 15 by an inaugural run for various government and industry leaders and the press, January 16 commemorated the first public use of our new type mobile radio telephone service.

Through the cooperation of the Department of Commerce, the FCC and other departments of government, 6 radio channels in the 406-420 MHz band (Government Band) were allocated for use by the Bell System during the conduct of the trial. These channels will be returned to the Government at the end of that time.

With this allocation it was then possible to ask our Bell Telephone Laboratories to design and develop a new radio telephone system that would:

(1) Make maximum use of the six radio channels with continuous radio coverage between New York and Washington with the exception of the Hudson River tunnels.

(2) Provide transmission quality as close to regular telephone service as possible using the latest type telephone equipment available.

(3) Be familiar and easy to use by the public with rates attractive enough to encourage use of the service.

(4) Be able to provide incoming service *to* the trains as well as full customer dialing features *from* the trains.

And finally, a system which would be capable of testing the demand for improved public telephone service on trains. In short, a system with which we could conduct a full market trial.

And here's how it works. Suppose a business friend of yours, a Mr. Meyer, boards the 3:55 pm Metroliner in Washington on his way to New York. He takes his seat in a Metro Club car, but as the train pulls out of the station, he remembers he had planned to call his partner in New York before the end of the day.

He steps to a phone booth in the car, picks up the telephone and without depositing any money he hears the dial tone. Using modern TOUCH-TONE push buttons instead of a dial he dials direct to his partner's phone. Before the New York phone rings, he hears an operator asking him to deposit one dollar plus 10 cents tax for the first three minutes.

Mr. Meyer drops the money into a single slot built into the panel-type phone before him. The New York phone rings and the partner finds himself talking to Mr. Meyer on a train traveling nearly 110 miles per hour.

To see how this is done, let's look at the Northeast Corridor between New York City and Washington. The black dots on this map show the locations of the transmitters or "base stations" which have been installed to provide radio coverage for train telephone service along the route.

There are nine base stations equipped with a total of 34 transmitters and receivers including those to serve the Baltimore tunnels. All of these base stations are connected with a telephone center in Philadelphia, Pa. From here the dial equipment routes the call automatically anywhere in the country.

Philadelphia is also the location of the operators who provide any special help that may be needed in making calls.

As you can see on this map, there are six radio channels available for the train phone service. To make maximum use of this frequency space, the Bell Laboratories designed a system of transmission zones along the corridor. The design makes it possible for the system to handle 11 phone calls at one time.

The New York-Washington route has been divided in nine zones . . . one for each transmitting location. Each zone is about 25 miles long. As a train moves along, the phone service aboard that train is switched automatically from transmitter to transmitter on the same channel so that calls may continue through several consecutive zones. The shift from one transmitter to another is made so smoothly the caller is not aware of any interruption.

Each band of talking zones on a given channel is separated by three consecutive non-talking zones. For example, the pink channel has three consecutive talking zones; then three non-talking zones; followed by three more talking zones. In the case of the gray channel, there are two talking zones separated by three non-talking zones, then followed by four talking zones. This approach is what makes it technically possible to have as many as 11 calls in progress at one time along the route.

As the train leaves one zone and enters the next, the telephone equip-

Editor's Note: This is an abstract of a paper presented at the Western Sectional Meeting of the Communication & Signal Section, AAR, in Omaha, Neb., April 15, 1969.

ment aboard the train interacts with a zone marker placed in the track bed. This marker tells the equipment whether the train is entering a talking zone or a non-talking zone for each of the six channels.

Before the train enters a non-talking zone, a light flashes on the telephone warning the caller his call will end. The telephone system works in such a way that a passenger making a call is assured a minimum of 12 minutes of time on the telephone, even with the train traveling at its top speed of 150 m.p.h.

We can get a better idea of how this works by looking at what happens when Mr. Meyer makes his call as his train passes through Zone 8 served by the Baltimore transmitter. As he picks up the telephone, the equipment has a choice of three channels—red, gray and pink. Since this train is headed north, the equipment does not choose the red channel because it knows the channel isn't available past the present zone.

Instead, it will seize either the pink or gray channel. A channel is not selected unless it is idle and can assure the caller of use through at least one full zone.

This logic built into the phone equipment works the same way in the opposite direction for southbound trains. A call being placed from a train entering Zone 6, for example, will be routed to either the blue or gray channel. Again, it does not select the green channel since it is not available in the next zone.

If both channels pink and gray had been in use when Mr. Meyer wanted to make his call, a "Channels Busy Lamp" would have gone on as he lifted the handset. In that case, another channel probably would have become available in a few minutes, since in any zone there are 3 or 4 talking paths available. While this examples involves only 2 trains, there will be more trains operating within the system at one time.

The user has as many choices regarding the type of call he wants to make as he has from any public phone. All calls from the train can be dialed direct. The call travels from the train to telephone equipment in Philadelphia where the operator at the console is to receiving equipment along the route, brought in, then on to its destination.

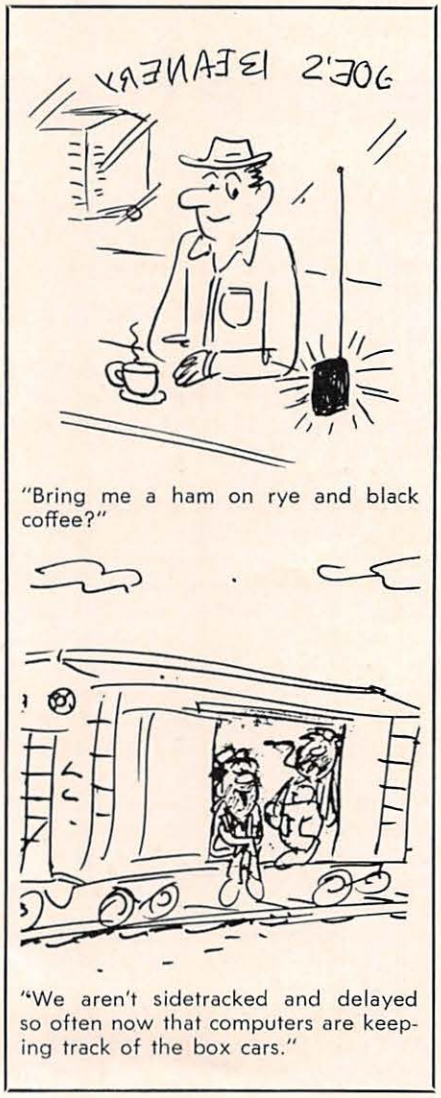
When Mr. Meyer made his call, he merely dialed the area code and telephone number since his was a station to station call. A "O" followed by the area code and number tells the operator that the caller wants to make a credit card, person-to-person or collect call, or charge his call to a third number. She will come in on the line to handle details of the call.

Any caller who wants help in making a call can get it just by dialing "Operator". A mobile telephone operator in Philadelphia will answer.

Let's suppose Mr. Meyer's partner was away from his desk when the call arrived. Mr. Meyer could have left the number of his train phone with the secretary and asked to be called back. In that case, the partner would have dialed his local operator and asked the mobile operator to connect him with the Metroliner. The mobile operator would dial the number of the train phone given her, the phone would ring, and Mr. Meyer sitting nearby expecting the call, would step over to the phone and answer.

For incoming phone service in general, mobile operators in Philadelphia have the number available of a Metro Club car phone on each train. As each train pulls out of New York or Washington, a railroad attendant in one of these cars dials "Operator" and gives her the number of the telephone in his car.

She keeps this number at hand until the train is scheduled to end its trip. To reach someone on the train, she dials this number and asks the attendant to announce the call over the train's paging system. The announcement will ask the person being called to dial "Operator" from the nearest phone. The operator then will complete the call.



"Bring me a ham on rye and black coffee?"

"We aren't sidetracked and delayed so often now that computers are keeping track of the box cars."

The voice that asked Mr. Meyer for the coin deposit was that of an operator sitting at a console like this. She's working at what we call a Traffic Service Position—the latest type of equipment for handling direct-dialed calls that require operator assistance. It's not a switchboard because all the switching is done by the automatic equipment in Philadelphia. At this console, the operator uses push-buttons to collect coin deposits, register credit card numbers for billing, and to handle any other operation needed to process the call.

Our filed tariff with the FCC specifies a minimum rate of one dollar for a three-minute call. This means that a call from the train to any city in the corridor will be one dollar plus tax for the first three minutes. We feel this rate makes the service attractive to the user in terms of price as well as convenience, especially for calls to cities within the corridor.

This rate takes into account factors such as the value of the service, the present rates for similar type calls between the cities in the corridor, as well as the cost of providing the service.

For calls to cities outside the corridor, charges will be the same as if the calls were made from Philadelphia with a minimum of one dollar. We have used Philadelphia as the rate center for these calls since it is closest to the midpoint of the corridor.

Maintenance of the phone service is performed at New York, Philadelphia and Washington.

Since the first phone call was made from a Metroliner on January 16, the passengers on board the two trains presently operating are placing approximately 150 calls per day. In addition, 12 attempts (5 completions) are being made to reach passengers on the train.

Each train consists of 4 Snack Bar coaches and 2 Metro Club cars for a total capacitty of 308 passengers per train. (34 passengers in each Metro Club car and 60 in each Snack Bar Coach). As regular coaches become available to the Penn Central, the train consist will be altered to include combinations of Snack Bar Coaches, Coaches and Metro Club cars as required to satisfy the reservations demand.

Presently, therefore, we have 6 telephones per train or 12 telephones in service for approximately 6 hours per day generating these 150 calls with an average conversation time of just over 3 minutes per call.

News Briefs

● COMMUNICATION & SIGNAL SECTION, AAR, moved its office to 1920 L Street, N.W., Washington, D.C. 20036, effective April 28, 1969. Telephone number is 202-293-4125.

● DEPARTMENT OF TRANSPORTATION has sponsored development of an obstacle detection system for high speed vehicles capable of detecting objects as small as an inch in diameter within a 600-ft range on a track or guideway.

The feasibility model was built by Radio Corp. of America for the Office of High Speed Ground Transportation, which is investigating the technologies required for 200 to 300 mph vehicles of the future. Such a vehicle would need positive indications that its tracks or guideway is free of obstructions two to three miles ahead, far beyond human sight limits.

The RCA scanner, positioned alongside the track, sends a very narrow, invisible infrared beam just above both tracks to a retroreflective strip fastened on the opposite side of the track. If no object blocks it, the beam is reflected back to a receiver in the scanner, indicating that the way is clear. Should the light beam detect an object one inch or more in width, however, there is either a very faint signal or none at all, and immediately the traffic controller for the sector of track is electronically alerted. DOT estimates that ten to twenty scanners will be required for each mile of track.

Resembling a small lighthouse in appearance, the scanner contains both a "laser transmitter" and receiver in its base. An accurately controlled revolving mirror at the top of the "lighthouse" reflects the transmitted signal across the tracks, and also serves to reflect the returned signal to the receiver.

Edward J. Ward, Chief of OHSGT's Engineering Research and Development Division, explained that infrared lasers are being used as the light source for the system because of their low power requirement and narrow beam, and because receivers designed exclusively for infrared light will not react to extraneous light sources, such as train and auto headlights.

RCA's David Sarnoff Research Center has already designed and tested for DOT a feasibility model of the laser scanning system, which presently has a range of 600 ft. Developed and built at RCA's Aerospace Systems Division, the scanner has also been tested and demonstrated on a special segment of track on the Penn Central at Princeton, N.J.

● GRADUATE ENGINEERS' starting salaries for years 1967-68 ranged up to $50 more per month than in the 1966-67 period. According to a study by the Engineering Manpower Commission of the Engineers Joint Council, electrical engineering graduates in the '67-'68 period received starting salary offers averaging $774 per month compared to $728 per month for the previous year. Civil engineering graduates were offered $750 per month to start as compared to $706 per month average in the '66-'67 period, Industrial engineering graduates rated starting salaries averaging $757 per month average in the 1967-68 period as against $707 for the 1966-67 period. In the same two periods, mechanical engineering graduates were started at $768 and $720 per month, respectively.

● ILLINOIS CENTRAL has purchased a centralized radio control system from Marquardt Industrial Products Co. The new system will enable Chicago based dispatchers to communicate directly by voice radio with any of the base stations and mobile units operating on the Chicago-New Orleans line. The modulated tone signaling feature provides a capability of operating a number of stations on a single voice circuit. The technique incorporates a station select provision which isolates the particular radio base station in the area of the mobile unit the dispatcher wished to talk to. The system will provide control of 22 mainline radio base stations from 10 dispatcher positions and a hotbox control center located in Chicago.

● NORFOLK & WESTERN has placed in service its computer operation called SCOOP for freight car location. By means of Western Union's Telex, shippers can ask the N&W's computers for the location of a specific car and the answer will be flashed back in seconds. SCOOP, which is short for System for Computer Oriented Operations, maintains an updated file on each car on the N&W system.

Every time a car moves, data is sent directly to the Roanoke central computer for recording of the car initials and number, location of last movement, type of movement (whether arrived at destination, interchanged with the connecting carrier, etc.) whether loaded or empty, the date and time, and other information.

Machines have been installed at 60 yards throughout the N&W system to funnel car location information into the central computer. Fifteen inquiry devices have been installed to serve major transportation and traffic offices. Additionally, Telex units are in service in 55 N&W traffic offices throughout the United States and Canada to serve shippers, and additional units are being installed in other N&W traffic offices.

The N&W now receives an average of 6,500 car location inquiries daily. N & W personnel expect an immediate increase of 1,000 inquiries each day when shippers begin using the service.

● SANTA FE has received approval from former acting administrator, J. H. MacAnanny, of the Federal Railroad Administration, to remove a continuous inductive three-speed automatic train control system, with three indication cab signals and without wayside signals except home signals at interlockings and install, in lieu thereof, a traffic control system, with wayside signals between Pequot, Ill. and Fort Madison, Iowa, 167.5 miles. Also, the centrally controlled wayside signal system to be installed should be the three-block, four-aspect system as generally described in American Railway Signaling, Principles and Practices, revised April 1955, published by the AAR, pages 20-21.

Railroad Personnel

● CHESAPEAKE & OHIO/BALTIMORE & OHIO: **Cutris E. Pelfrey,** signal inspector, appointed assistant engineer of signal reports and agreements at Huntington, W. Va. **Paul R. Bland,** leading signal maintainer appointed assistant supervisor of signals at Punxsutawney, Pa. **Samual A. Rutherford, Jr.,** assistant supervisor of signals, appointed supervisor of signals at Clifton Forge, Va., succeeding the late **J. A. Tolley. Robert L. Peery,** signal maintainer, appointed assistant supervisor of signals at Clifton Forge. **Roland D. Jennings,** leading signal maintainer, appointed assistant signal supervisor, Lima, Ohio. **Melvin R. Allen,** signal maintainer, appointed assistant signal supervisor at Chicago for B&OCT.

● FRISCO: **R. B. Blaylock,** project engineer communications and signals department, appointed superintendent communications, succeeding **R. M. Laurenson,** retired. **M. Barrow, Jr.,** communications supervisor, succeeds Mr. Blaylock as project engineer. **K. E. Bassham, electronics** engineer, appointed communications supervisor. **J. H. Webster,** appointed electronics engineer. All men are headquartered at Springfield, Mo.

● RICHMOND, FREDERICKSBURG & POTOMAC: **Andrew H. Lamothe, Jr.,** assistant signalman, appointed assistant communications inspector at Potomac Yard, Alexandria, Va.

Supply Trade News

● GENERAL RAILWAY SIGNAL CO.: **Charles Powdermaker** appointed manager systems engineering department.

● KOPP GLASS INC.: **Willard A. Provost,** assistant sales manager, appointed general sales manager. He will continue his duties as acting sales promotion and advertising manager. **Ernest L. Yost,** acting assistant director of research and engineering, appointed director of research and engineering succeeding **Dr. C. E. Leberknight,** retired.

● LITTON INDUSTRIES: **Brian Knight** appointed president of the newly formed Revenue Control Systems Division which includes Advanced Data Systems Corp. and Taller and Cooper Inc.

(Please turn to page 27)

Data Modem Characteristics

Prepared by Leo J. Ritter Staff Engineer, Communications & Signals, Penn Central. Reprinted by permission of George McCann, Secretary, Communication & Signal Section, AAR.

Manufacturer	General Electric	General Electric
Model	TDM 420 Modem	TDM 500 Modem
Transmit and/or receive	Transmit & receive	Transmit & receive
Full and/or Half Duplex	Full duplex	Full duplex
Dial up or Private Line Application	Private line	Private line
Turn around time (HDX)	—	—
Automatic answer capability	No	No
Type modulation	AM Vestigial	Restored polar
Operating Frequencies	60-104,000 Hz	7,000-165,000 Hz
Clock, internal or external	In TDM 400	Internal or external
Loop back testing feature	Yes	Yes
Error rate	—	—
Error detection and/or correction	None	None
EIA RS-232-B interface	No	No
Bit or character rate	Up to 50,000 bit/sec	Up to 230.4 k bits/sec
Serial or parallel transmission	Serial	Serial
Impedance to line, ohms	135/150	135
Impedance to data equipment, ohms	Matches line	90-120
Voltages to and from data equipment	from TDM 400	5 or 23 ma
Frequency stability	±0.01%	—
Level stability	—	—
Output levels to line, dbm	−30 to −45	−6 to +6
Input levels from line, dbm	−5 to −20	−30 min.
Line requirements, frequency response	60-104,000 Hz	Built in equalizer for cable pair
Line requirements, envelope delay	Approximately ±5 micro sec	Built in equalizer for cable pair
Line requirements, impedance	135/150	135
Line requirements, signal to steady noise	—	—
Line requirements, signal to impulse noise	—	—
Method of operation	4 wire	4 wire
Temperature and humidity limits	0 to +50 deg. C	0 to +50 deg. C
Power requirements	−20 to −60 volts DC or 115 volts AC	115 volts AC, 15 watts
Dimensions and weight	9″ x 9″ x 20″, 35 lb	11″ x 9″ x 21″, 35 lb
Digital or analog	Interface with TDM 400	Digital

NEWS BRIEFS

(Continued from page 25)

● RAILROAD ACCESSORIES CORP.: **William W. Beard,** general manager of the Fairdale, Ky. plant, has been elected vice president-general manager of this Louisville operation.

● OKONITE CO: **Donald C. Huber** appointed manager-advertising and public relations.

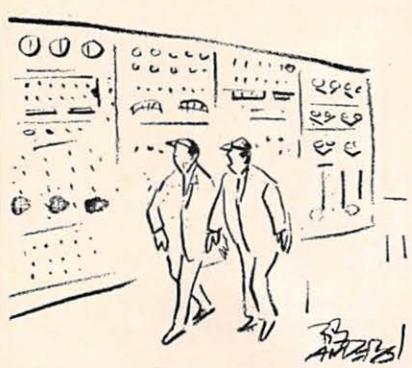
● THE RAILS CO.: **William C. Sneed,** formerly industrial sales manager for Protane Corp., appointed to a sales position in the Chicago office.

● SANGAMO ELECTRIC CO.: **Henry E. Stelzer** appointed marketing manager of the information systems group. **Vern L. Zugenbuhler** appointed marketing manager of the data systems group. **John F. Rilling** continues as marketing manager of the communications systems group.

● STANCIL-HOFFMAN CORP.: **Stan Harris** appointed director of marketing with headquarters in Hollywood, Calif.

● SYLVANIA ELECTRIC PRODDUCTS INC.: **John W. Brazil** appointed marketing manager—automatic identification systems for the commercial electronics division with headquarters in New York City. **George K. Hausser** appointed regional manager railroad sales, with headquarters at 4700 Parkside Ave., Philadelphia, Pa. 19131. **Donald W. Wessels** appointed midwestern regional manager railroad sales for commercial electronics division at Sylvania's transportation control systems sales office at 2001 N. Cornell Ave., Melrose Park, Ill. 60160. **Richard J. Schiefelbein,** former industrial engineer, Penn Central at Chicago, has been appointed engineer for Sylvania's transportation control systems, with headquarters at Melrose Park, Ill.

● WESTERN-CULLEN DIV., Federal Sign & Signal Corp.: **Robert G. Clawson,** formerly sales representative for W-C in the Chicago area, has formed the Clawson Railway Supply Co. with headquarters in St. Louis Mo. Mr. Clawson will represent W-C in the south and southwest sections of the U.S.



"It also replaced $275,000."

View from the Crossarm

● *abc's of Electronic Test Equipment* is a book which analyzes fundamental test instruments in detail, including their basic construction, operating details, and uses. Several discussions of new instruments have been added to this enlarged second edition, including information on high-quality oscilloscopes, detailed coverage of the new solid-state VOM audio generators, solid-state signal generators, fm signal generators, and tunnel-diode dip meters. In addition, a new chapter has been added which includes color bar and dot generators in both tube and transistor versions.

The instruments described in this book range from basic types to those used in specialized fields. Eleven chapters in the book cover the meter; volt-ohm milliammeter; vacuum-tube voltmeter; solid-state VOM; battery, diode and transistor testers; tube testers; the signal tracer; the oscilloscope; battery eliminators; the signal generator; and TV color bar and dot generators. *abc's of Electronic Test Equipment* by *Donald A. Smith, Howard W. Sams & Co., Inc., 122 pages plus index; Price: $2.95.*

● *Management and the Computer in Information and Control Systems,* designed to bridge the gap between the manager and the computer expert in problem definition and communication, provides a basic framework which the manager can use to define and analyze his systems requirement. The authors consolidate several proven concepts and introduce various new ones which are put together to form a meaningful package of state-of-the-art methods that will help the operational manager to make maximum effective use of the computer.

This practical volume dispells the mystery that has grown up around computer technicalities and techniques and shows the computer to be "a very handy and untiring servant allowing us to utilize the mathematics of yesterday and today in our quest for better decision making formulae."

Within the framework provided by the authors, a manager can analyze his own problem area and relate this analysis to a computer-oriented frame of reference. Fundamentals are described and shown in their application to the management environment; case studies are used to depict the application of these tools and techniques to show the manager how to begin to apply them to his own area of concern so that he may state his requirements to the computer expert in meaningful terms.

Chapters 1, 2, 3 and 4 define the "what" of a management control system; Chapters 5, 6, 7 discuss "how" to start developing a management information and control system; Chapters 8, 9 and 10 introduce some of the tools presently available to aid the manager. Case studies are used in Chapters 11, 12, 13 and 14 to describe the application of the tools and precepts presented. These case studies tie the theory of control to the management hierarchy. The final chapter gives a glimpse into future uses of the computer by management. *Management and the Computer in Information and Control Systems by Bartow Hodge, Program Administrator, IBM, Data Processing Division; and Robert N. Hodgson, Vice President, Synergistic Software Systems Inc., 282 pages plus index; McGraw-Hill Book Co.; Price $13.50.*

● *Semiconductors: From A to Z* covers the entire range of transistors and semiconductors used today—from basic diodes and transistors to FETs, MOS FETs, tunnel diodes, integrated circuits, varicaps, photo FETs, light-sensitive and light-emissive devices, incandescent and luminescent optic-electronic circuits, unijunction transistors, field-effect diodes, SCR and zener diodes, etc.

The content begins with a review of how basic semiconductors work, including types and function, how a transistor conveys a signal, transistor biasing and self-biasing techniques, effects of temperature on operation, factors limiting transistor frequency response, etc. Succeeding chapters delve into the mystical arena of field-effect transistors by explaining the differences between FETs and regular transistors; junction FET applications, frequency response, temperature effects, and depletion-type and enhancement-type MOS FETs.

Considerable attention is given to integrated circuit applications—variable-current and constant-current sources, unbalanced differential amplifiers, IC applications in FM and TV receivers, TV sound circuits, discriminator circuits, and cascade amplifier networks. The use of varicaps is also covered, as well as unijunction transistors, field-effect diodes, zener diodes, SCR diodes, 4-layer diodes, diacs, and triacs. Several chapters are devoted to the new field of optic-electronic circuits, including uses for photovoltaic and photoconductive cells, photodiodes, phototransistors (FETs and MOS FETs), light-emitting diodes, optic lenses, fiber optics, incandescent couplers, luminescent couplers, and a "needle-less" phono pickup that plays standard records. The final chapters deal with constant current and voltage regulating systems and DC-to-AC-to-DC converters. *Semiconductors: From A to Z by Phillip Dahlen Tab Books, 272 pages, Price: $7.95 hardbound, $4.95 softbound.*

SALES ENGINEER

Chicago based railway supply company has opening for sales engineer. Prefer man with some experience in CTC and crossing protection work. Sales experience preferred, but not required. SEND RESUME STATING SALARY REQUIREMENT TO: *Box 1000, Railway Signaling & Communications, 29 East Madison St., Chicago, Ill. 60602*

Data Modem Characteristics

Manufacturer	Sangamo Electric	Sangamo Electric
Model	202D1 & D2	201B1
Transmit and/or receive	Transmit & receive	Transmit & receive
Full and/or Half Duplex	Full or half duplex	Full & half duplex
Dial up or Private Line Application	Dial or private line	Private line
Turn around time (HDX)	—	—
Automatic answer capability	Yes, with Bell 804 set	Yes (optional)
Type modulation	FM	Differentially coherent four phases, carrier at 1800 Hz
Operating Frequencies	1200 Hz mark, 2200 Hz space	Carrier at 1800 Hz, spectrum 600-3,000 Hz
Clock, internal or external	None	Internal or external
Loop back testing feature	Yes	No
Error rate	—	—
Error detection and/or correction	—	—
EIA RS-232-B interface	Yes	Yes
Bit or character rate	1200 to 1800 bits, asynchronous	2400 bits/sec synchronous
Serial or parallel transmission	Serial binary	Serial binary
Impedance to line, ohms	600/900	600/900
Impedance to data equipment, ohms	EIA RS-232-B	EIA RS-232-B
Voltages to and from data equipment	EIA RS-232-B	EIA RS-232-B
Frequency stability	±1.5 dbm	.01%
Level stability	—	—
Output levels to line, dbm	0, −3, −6, −9 dbm	0 to −8 dbm in 2 db steps
Input levels from line, dbm	0 to 42 dbm	*−42 to +6 dbm in 4 ranges with comp. eq. in; *−50 to −2 dbm in 4 ranges with comp. eq. out; * 30 db dynamic range on each option
Line requirements, frequency response	DDD-1200 bps C1-1400 bps C2-1800 bps	Voice grade— C2 conditioning
Line requirements, envelope delay	ditto	ditto
Line requirements, impedance	ditto	ditto
Line requirements, signal to steady noise	ditto	ditto
Line requirements, signal to impulse noise	ditto	ditto
Method of operation	2 or 4 wire	2 or 4 wire
Temperature and humidity limits	+10 deg. C to +50 deg. C	10 deg. C to 50 deg. C
Power requirements	117 volts AC	117 volts AC
Dimensions and weight	19" x 5¼" x 10½", 25 lb rack mounting 17½" x 5¼" x 10½", 25 lb desk type cab.	19" x 10½" x 10" rack mounting 17¾" x 11" x 10", desk type cab.
Digital or analog	Digital	Digital

Feedback

Semiconductors

. How do you test the conditions of mi-conductors in working circuits and it of working circuits for: forward volt-e drop across diode, for excessive leak-e current, DC gain of triode or tetrode evice, AC gain of triode or tetrode de-ce, characteristics where equipment op-ates in various local temperature ranges?

. When checking a diode in a working rcuit our maintainers use a high input sistance solid state DC multimeter to ieck the voltages from either side of the iode to common, to compare these read-gs with the optimum voltages shown on ie schematic diagram of the equipment nder test. Normally the forward voltage rop across the diode is not checked in working circuit (power on). Instead, the ower is turned off and the forward and everse resistance of the diode is meas-red with the DC multimeter and com-ared with a new diode. If there are large ifferences, one end of the diode is lifted rom its circuit and the forward and re-erse resistance checked again. If the eadings as compared to the new diode iffer greatly, the diode is replaced.

Excessive leakage current in semi-con-uctors will generally show up when naking voltage checks in working cir-uits. The DC multimeter is used to heck the voltage at each element of the emi-conductor. If these voltages vary reatly from the optimum values shown n the schematic diagram of the equip-nent, it indicates that the semi-conductor nay be defective. The semi-conductor is hen removed from the circuit and the orward and reverse resistance are mea-ured from base to emitter, base to col-ector and emitter to collector. A lower han normal reverse resistance reading f any one of these tests will indicate a ransistor with excessive leakage current.

The DC gain of triode or tetrode de-ices are not normally checked on our quipment. Troubles are isolated by mak-ng voltage checks in working circuits. The same procedure is used as check-ng transistors for excessive leakage.

The AC gain of triode or tetrode de-ices is measured by comparing the in-ut AC level to the output AC level sing a high input impedance AC volt-neter with a RF probe.

Characteristics of equipment operating t various local temperature ranges are ot normally checked by our railroad. he equipment is purchased to operate n the environment in which it will be nstalled. If the equipment requires main-enance due to being temperature sen-tive the various components are heated ith a soldering iron and/or chilled with reeze-mist to locate the defective part.

Paul A. Flanagan, Superintendent of Communications, Chesapeake & Ohio/Baltimore & Ohio

. Preliminary in-circuit testing is accomplished by visual inspection and the measurement of DC bias voltages, comparing the readings with service manual information. If this does not reveal the trouble, AC voltage stage gain measurements also provide information in locating defective devices of components. There are several in-circuit type transistor testers which perform quite satisfactorily in locating defective transistors.

Out-of-circuit transistor and diode checking is accomplished mostly by the use of ohm meters. When available, a transistor checker does provide some additional useful information.

Different techniques and considerations must be employed between those devices used for low frequency or low speed switching and high frequency or high speed switching. In many cases where field servicing is employed and unit construction permits, substitution with known good components is the quickest and most effective means of locating defective semiconductor devices. Other than in initial circuit design work and rare instances of temperature sensitivity troubles, we do not check the characteristics of semiconductors over the various operating temperatures.

L. Ralph Thomas, General Superintendent Communications & Signals, Sante Fe

Pole Lines

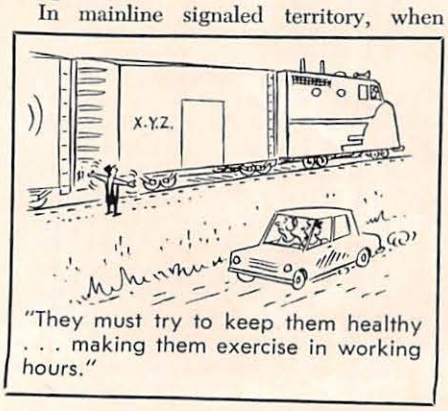
Q. How do you physically check on the condition of pole lines?

A. Until recently, the Western Union Telegraph Co. owned and maintained virtually all of the pole lines on the Boston & Maine. The signal crossarm or arms was owned and maintained by signal department forces. Weak or broken poles were reported to Western Union Telegraph whose forces made necessary repairs.

Within the past few years the telegraph company has been selectively giving up portions of its lines. The lines to be given up are offered for purchase by the railroad at a nominal price. On unsignaled branches of the railroad, the pole line is generally removed by Western Union forces except for a few poles purchased by the railroad where required by crossing protection.

In mainline signaled territory, when Western Union advises they intend to abandon a portion of their line, we make arrangements for a joint inspection of the line. The line is thoroughly covered by Hi Rail vehicle inspecting each pole visually and keeping notes of its condition. Western Union prepares an estimate of the cost to rehabilitate the line and the purchase price of the line is based on its being in good condition when we acquire it.

W. W. Hartzell, Engineer of Signals and Communications, Boston & Maine



"They must try to keep them healthy . . . making them exercise in working hours."

A. The preferred test is by means of a pike pole 8 ft long applied to the pole 8 ft to 12 ft from the ground on the side which has no support from wires or messenger. Rock or sway the pole sufficiently to determine its condition.

If the pike pole is not available, remove the dirt from around the pole to at least 12" below the surface of the ground. Use a heavy screw driver or similar tool to prod the decayed wood from around this portion of the pole to determine the amount of sound wood remaining. Also sound the pole to the height of 4 ft with a hammer or other suitable object to determine the presence of hollow heart.

If swaying or prodding and sounding of wood pole indicates a doubtful or unsafe condition, or if it is known that it is broken, rotted or burned off at base and/or guys are deteriorated or unsuitable or if pole is untreated, temporarily safeguard pole by the method suitable to the condition.

Harvey Alexander, Manager Communications & Signal Systems, Penn Central

A. Our method of inspection of our pole line is by the tried and true method of "eye and ear". We observe the pole top condition, note any long grain and outer shell vertical cracks, soft spots or holes that birds and insects are working on, and most importantly, sound the base of the pole from the ground line to head-height with a 3 or 4 lb broad hatchet or hammer. If sounding indicates hollow rot the ground around the pole is removed for 10 or 12 inches deep, the rotted wood removed and, from all evaluations, the replacement or retention of the pole is determined.

R. H. Murphy, Telephone and Telegraph Inspector, Lehigh, Valley

Dust in Cases

Q. How do you prevent the entry of dust from passing trains, particularly those handling pyrites, coal, ore or crushed stone from entering wayside relay cases or bungalows?

A. We use WABCO wayside relay cases and bungalows. These are equipped with louvers at the top and bottom of the doors, and lined with a fine bronze screen mesh. Entry of dust from passing trains has not posed a problem.

Warren J. Young, Engineer Signals and Communications, Bessemer & Lake Erie

Railway Cybernetics

● Association of American Railroads outlined its position with respect to interdependence of computer and communications services in FCC Docket 16979. The AAR's statement is abstracted herewith:

The railroads of the United States are major users of both computers and communications facilities. Most railroads have had, from dates preceding the founding of the country's major telephone and telegraph companies, comprehensive communication networks paralleling lines of road. Today they operate both telephone and signal lines as well as some of the largest privately owned microwave systems in the world. Railroads, in common with certain other right-of-way companies and utilities, are in a special situation with respect to the subject of this inquiry because they 1) own and operate private communication systems which collectively extend to substantially all parts of the United States; and 2) are at the same time extensive users of common carrier communication facilities. Authority to integrate privately owned and leased communication systems or facilities with privately owned and leased data processing (computer) systems is therefore of primary concern to the AAR and its members.

As of December, 1967, there were 235 computers installed in the railroad industry, excluding analog, hybrid, or digital computers and terminals used for control in automated freight classification yards. Although some roads purchase their equipment while others lease, the aggregate rental value of these systems would be approximately $3,400,000 per month. Their purchase would represent an investment of some $170,000,000. Of the 235 systems now installed, 100 are of recent manufacture, so-called "third generation" computers incorporating the latest technological advances; 75 of these were installed during 1967. There are some 30 to 40 additional computers on order. At the present time, the greatest portion of computer usage by the railroads is on "in house" computers under immediate railroad control. There are in addition some purchases of time on outside computers through contracting of data processing services from computing service companies. Some outside research contracted for by the industry also necessitates outside computer activity. There is also some use made of time sharing and computational services offered by service bureaus.

Although the information systems on railroads vary in functions and capacities, they all point the way toward the railroads' ultimate goal of "total information systems"—computer programming designed to provide the broadest range of operational information to all management levels on a timely basis.

Railroad transportation operations are characterized by a large number of variables. It is extremely difficult to measure the numerous variable changes and to assess the resulting interrelationships. Because analytical techniques do not need to operate in a static environment, but can adopt environments permitting alternations of conditions and parameters, railroad operations research personnel have used computer simulation models as a primary means of investigation. The objective of computer simulation is to ascertain gross improvements in comparing one alternative to another. Among the existing mathematical models now available in different configurations are: Models of over-the-road operation; Models of terminals and Models of motive power assignment. Other models will be developed to utilize cost data of individual railroads to produce dollar evaluation of system performance.

Since the Commission's inquiry asks for estimates of computer/communication uses into the next decade, it should be noted that computerization of freight rates is a project being approached on an industry-wide basis, including cooperation with shipping organizations. Computerization of complex freight rates involves efforts to put thousands of rates into computer files for instant reference in pricing transport services on a real-time basis as requests are presented by the shipping public. Here again there appears a need for computer-to-computer communication.

Data processing equipment is enabling railroad management to achieve new break-throughs in operating efficiencies, ranging from the prompt location and placement of freight cars to planning the advance switching of incoming trains. By keeping a constant record of all on-line freight cars, both loaded and empty, a railroad is provided with a conspectus of its entire freight transport operation, including types of cars, ownership, location, load status, destination, and various operating conditions. To shippers and receivers, this kind of information system gives a greater degree of certainty in scheduling shipments and deliveries. To the railroad, it means better car distribution and utilization. The supply of rolling stock on the entire system can be studied, and car availability compared with the need for specific types of equipment. The typical on-line system for handling shipper inquiries now in use on railroads or planned for the future will operate essentially as follows: The customer/shipper dials the railroad computer direct at any time and requests location of freight cars by indicating car initial and number for any quantity of cars. If requests are not computer-originated, the origination of messages could be by punched paper tape, punched card, or manual keyboard, using terminal devices such as Teletypewriter, IBM 1050, or comparable equipment. At the present time appropriate data sets procured from common carriers are interfaced with data processing equipment and the common carrier networks. The communication is provided by common carrier lines, direct distance dialing (AT&T's DDD network), or Teletype exchange (TWX), or Western Union's Teletype (Telex) to an automatic data set (DDD, TWX, or Telex) directly into the railroad's computer system. Upon acceptance of the message, the requested information is retrieved from the computer's memory storage and a computer programmed response is generated giving for each car inquired about its last movement, such as date and time of movement, in or out of a specific yard, in train moving over the road, or to interchange or industry siding. The reply is made via communication as above, terminating directly in the customer's computer, in hard copy form, punched paper tape, punched card, or in any combination. The railroad response is programmed to be completely automatic, and many shipper/customer's originations and receipts of messages are likewise automatic. Response time is in seconds with real-time on-line systems. Audio response devices, as well as video display equipment, are available.

One of the advanced computer/communications project pursued by the railroads and the AAR will be the first computerized system to keep track of the country's entire fleet of freight cars. Called the Telerail Automated Information Network (TRAIN), the system is designed to serve as an effective means of dealing with localized freight car shortages. The result will be better allocation and greater utilization of freight cars in meeting the nation's growing transportation demands, and better service to the shipping public. The automated rail data network is to be tied in directly computer-to-computer with the rapidly growing number of advanced information systems on railroads. Thus, TRAIN system paces the many improved techniques of data collection and transmission used by railroads to provide vital information for management decisions. Tele-Rail Central will be based at the AAR's Washington headquarters, with computer communication links to all Class I railroads throughout the United States and Canada. It will provide the AAR Car Service Division with timely reports of car movements between railroads and the current flow through principal rail gateways, and thus will permit more rapid mobilization of equipment to meet the transportation requirement for freight cars. It will be invaluable in times of national emergency. TRAIN was adopted on recommendations of top rail transportation expelts who studied the resulting benefits of a central interroad car movement information system designed to serve the shipping public. Obviously it will require extensive use of many types of communications, including all types of owned and leased facilities.

The railroad industry has adopted a nationwide system of Automatic Car Identification (ACI) to provide a common method for identifying, recording, and reporting to control points the ownership and

(Please turn to page 32)

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SINGER
INSTRUMENTATION

Circle 10 on reader service card on page 38

RAILWAY CYBERNETICS

(Continued from page 30)

identifying symbol of a freight car at any specified spot on a railroad's line without bringing the car to a stop and without depending on personal observation or manual recording. The recording of data as to the car movement, time, and place will be transmitted to central points for computer input on many individual railroads and in many cases on a real-time, on-line basis, either now or prospectively. The ACI system, tied in with electronic data processing equipment, will provide the shipping public with more economical, efficient, and dependable transport service, and rail management with a greatly improved utilization of railroad capital resources. The system will consist of specialized data collection terminals coupled to railroad communication and information centers via railroad-owned or leased communication facilities (including wire and microwave radio), the several communication common carrier services and facilities, and combinations thereof.

To the end of better communications between computers, this industry has been active in development and adoption of standardized coding systems:

—A standard commodity classification code (STCC).

—A universal machine language equipment register (UMLER) has been adopted and is in use covering all freight cars operating on the North American continent in interchange service.

—ACI numerical reporting codes have been adopted covering 1,300 reporting marks for direct communication from track-side scanners to computers.

—A Standard Package Code is under development.

—A Standard Point Location Code (SPLC) is under development.

—A Standard Route Code (SRC) is under consideration.

—A standarized shipper/customer identification is also being studied by shippers and transportation traffic organizations.

It is conceivable that in some cases two or more railroads may desire to share the use of a single computer, or to contract with some third person for the use of a computer on a part-time, full-time, or even "real-time" basis. In such cases, the communication circuits to such computers may be wholly railroad-owned, entirely leased from the common carriers, or a combination of both.

A number of railroads have been considering or have announced an intention to form service bureau type of subsidiary operations offering to contract for computer services for others.

Item B of the Commission's inquiry requests a description of the basis for and structure of charges to customers for the type of services that are anticipated in the next decade in computers and communications as shown in Item A of the response. The railroads do not now charge for information released to shippers after having been compiled and transmitted on railroad computers and owned or leased communication facilities. There is, however, the possibility that some railroads which provide such or extra information processing and communication service incident to transportation operations may recover some or all the cost of such service from those who receive it, particularly as or if, the amount of information is expanded to meet shippers' requests. As indicated earlier, some roads intend to offer special computer and information processing services by contracting with customers in need of such service.

In Item C of the inquiry the Commission has asked for information, views, and recommendations as to the circumstances, if any, under which any of the aforementioned services should be deemed subject to regulation pursuant to the provisions of Title II of the Communications Act.

—When involving the use of communication facilities and services.

—When furnished by established communication common carriers.

—When furnished by entities other than established communication common carriers.

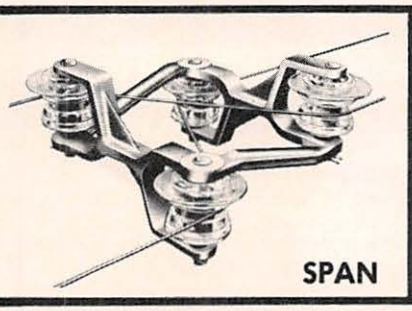
In the view of the railroad industry the service described, other than the provision of communication channels and facilities by the communications common carriers, are not and should not be subject to regulation under the provisions of Title II of the Communications Act or otherwise. Regulation of the communications common carriers would naturally apply to that portion of their activities which involves the transportation of information. Any processing, transformation, or translation of the information, any message switching or storing, or any other supplemental operation performed on the data should remain outside the scope of regulation and available on a competitive basis from any source, including the common carriers. It should be recognized that so-called "message switching," as used above, is not another means to permit direct and instantaneous transfer of intelligence, such as is the case with the switching of telephone circuits, but is in reality a message storage and retransmission function sometimes called store and forward switching.

Communications common carriers should not be permitted to discriminate in rates, by tariff restriction, company practices, or otherwise against the connection of any computer and its ancillary equipment with communication channels if such equipment meets the required engineering criteria, regardless of ownership. In other words, the common carriers should not be permitted to place any restriction on what is connected to their circuits at the points where those circuits are delivered to the customers, other than the necessary technical specifications of signal level, bandwidth, etc. In no case should the fact that a common carrier can provide both the communications facilities and the computer facilities give that carrier a competitive advantage over another entity offering computer facilities only.

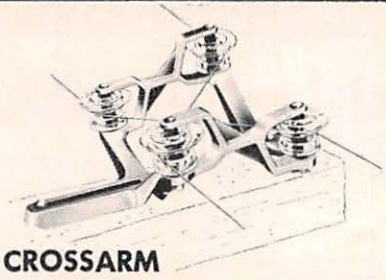
It is the opinion of the railroads that the objectives of the Communications Act and the public interest would be best served by allowing computer services, as

(Please turn to page 35)

45 of the 52 Class 1 Railroads in the U.S.A. & Canada Specify & Use CASE TRANSPOSITION BRACKETS



SPAN



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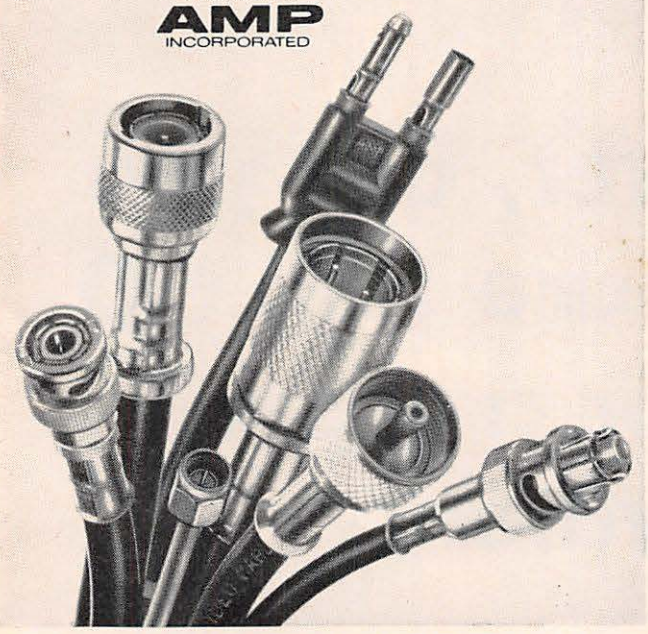

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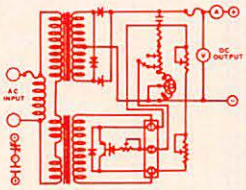

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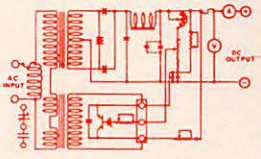
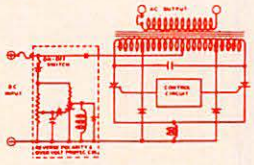


INVERTERS



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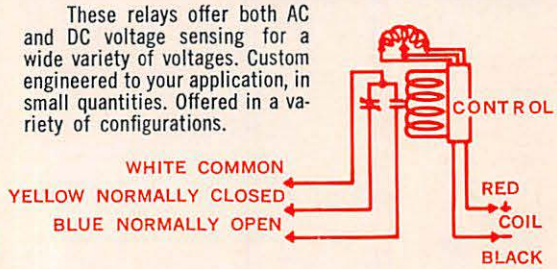

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C&D BATTERIES

DIVISION OF **ELTRA** CORPORATION

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Circle 7 on reader service card on page 38

RAILWAY CYBERNETICS

(Continued from page 32)

such, to evolve in a free, competitive market. Message-switching and other classes of computers are available for purchase or lease from a number of sources, and prevention of a monopoly therein would appear to be within the scope of the anti-trust laws. No changes in existing laws or regulations would seem needed. For these reasons, the railroads believe that computer services, as such, should not be subject to regulation apart from that afforded by the anti-trust laws. The data processing services envisioned by the railroads are not the type that fall into a category requiring regulation nor do they carry any of the economic characteristics of an activity requiring regulation in the public interest.

The existing regulatory procedures of the Commission appear to be consistent with insuring fair and effective competition between communications common carriers and maintaining an equitable rate structure in the supplying of communications services. As indicated above, the railroads believe that the sale of computer services, as such, should not be regulated.

Item G requests responses to compatibility of existing rate structure regulations and practices of current tariff schedules with present and anticipated data computers/communications needs of the railroad industry.

Tariff restrictions on the interconnection of common carrier communication facilities with customer-owned equipment and facilities should be eliminated. The communications common carriers should furnish the necessary information regarding the operating and engineering characteristics of the circuits provided, and the customer should then have the option of providing for himself a device which meets those requirements or of procuring it from the common carrier if it is offered. The common carrier should not be permitted to require excess equipment at the interface, such as the present Bell System requirement that the Model 801 dialer be used to dial up connections from the computer over Bell circuits even though the computer may be capable of doing such dialing by itself and satisfying all technical parameters. The test should always be whether use of so-called but mislabeled foreign attachments are beneficial to the railroad or transportation customer user and not detrimental to the public interest in the quality of service. Use of non-common carrier supplied modems should be subject to this test. The technical reasons for original prohibition are no longer valid.

For the present it appears that time and distance are adequate as a basis for constructing charges for the use of communication circuits, so long as the cost of providing those circuits is also considered. However, it would appear that distance is to become less important, considering as communication factors a plant in place and the emergence of satellites as well as channel band-width and microwave capabilities. Value of service has become a declining force as the basis for charges when the contributions of advancing technologies are assessed.

Shared use of equipment and services offered by communications common carriers should not be forbidden. Sharing the cost of a joint activity or service is well established in many other situations and many other industries.

Customers should not be restricted from any lawful use of the communications services offered which would not degrade other communications services offered by the same or other common carriers. The primary test should be potential detriment to the public switched network. "Resale" of communications services should be permitted, provided the "price" represents no more than a fair share of cost.

High speed data transmission may require channel bandwidths different from the present standard offerings. Tariffs should be such that any needed bandwidth circuit can be obtained on an equitable basis without payment for bandwidth greater than that used.

In judging the adequacy of present-day transmission facilities to meet requirements of computer technology, due consideration must be given to problems of conversion and updating of the nationwide networks. At the present time some common carrier facilities are inadequate because of the carriers' inability to maintain continuous service without interruptions. In addition, there is a need for clearer specification by the common carriers of the technical limitations on the use of given circuits (such as bandwidth, delay distortion, transmission loss, signal to noise ratio). Both carriers and users should specify more clearly the technical limitations and requirements of the various equipments. Transmission accuracy is important and requires continued improvement. Time sharing and real-time on-time operations, data banks, and complications of remote batch input/output inherent in services anticipated by the railroads as noted under Item A impose new and difficult requirements on communications common carrier capabilities.

Item J directs attention to the measures required to protect privacy and the proprietary nature of computer-stored data transmitted over communication networks, and respondents are asked as to: (a) Present and planned measures, and (b) Legislative and regulatory recommendations.

The measures currently employed and those in the planning stage for data processing in the railroad industry are adequate to protect both private and public interests. There are a number of hardware techniques available, including circuit building for file protection, memory protects, and register control. Encryption devices and scrambling capabilities seem to offer endless opportunities for the degree of security needed in the railroad industry. Of course, the latest computers offer newer and broader protective features. Software programming likewise offers capabilities for developing protective measures, probably far beyond the needs for rail operations. These include identification, coding, password, and similar practices. Call back, answer back, station, and personal key identification procedures can be adopted

(Please turn to page 36)

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Montreal, Quebec, Canada

RAILWAY CYBERNETICS

(Continued from page 35)

for validation of the propriety of inquiry.

It is the usual practice to follow appropriate constraints to the extent of knowledge of programming, coding and mechanized procedures as well as limiting physical access to computer sites at central and terminal locations. Access is also limited to system documentation, including records, files, and software operating systems and programming. In this respect, it is quite common that analysts, programmers, and coders do not have free access to computer operations; and computer operators are not ordinarily knowledgeable about details of computer programs. However, extensive application of protective hardware and software is expensive both in dollars and efficiency. This must be weighed in a business sense against the risk involved in possible unauthorized access to computerized data. In any case, no legislative or other governmental action seems indicated.

Product News

● INFORMATION DISPLAY SYSTEMS are described in bulletin CT-210. The display systems basically consist of cathode-ray tube units connected up to transmission systems or computer output systems. Descriptions, photographs and block diagrams are included in the bulletin. *Sanders Associates Inc. Circle 101 on Reader Service Coupon.*

● MULTIPLEX: Type 29A radio multiplex is a solid-state frequency-division type of equipment that provides up to 5 two-way voice and remote-control communication channels. Within each channel, the system provides a signaling tone at 3,825 Hz that can be used for dialing, ringing, or energizing radio base station relay circuits. A new brochure describes this equipment and includes engineering specifications. *Cardion Communications. Circle 102 on Reader Service Coupon.*

● RADIO SIGNALING: Selective signaling encoders for mobile radio service are described in bulletin SE-142A. These encoders provide for dial operation of two-way radio equipment. *Secode Electronics. Circle 103 on Reader Service Coupon.*

● TELETYPE model 37 line of equipment features three terminals in the 150-wpm operational speeds (15 characters per sec). Model 37 ASR is an automatic send-receive set, the KSR is a keyboard send-receive set, and the RO is a receive only unit. *Teletype Corp. Circle 104 on Reader Service Coupon.*

● TERMINAL: A fly sheet describes the 46A single channel terminal which furnishes a voice channel with choice of in-band or out-of-band signaling. Alternately, the voice channel may be used jointly with telegraph and data transmission up to 200 bps. The terminal may be used for establishing as many as 3 drops at a single location and up to 12 separate dropoffs along a microwave route. *Lenkurt Electric Co., Inc. Circle 105 on Reader Service Coupon.*

● RADIO CONTROL: Three new types of radio base stations are described in brochure TIC 3252 and include a remote control console, a remote desk set, and a local desk set dispatch point. These three units provide communication through the base station without a person leaving his desk to go to the base station location. *Motorola Communications & Electronics Inc. Circle 106 on Reader Service Coupon.*

● SIGNALING: The 927A in-band signaling system has been designed to provide reliable single-frequency signaling for mes-

(Please turn to page 38)

TELEGRAPHER'S TREASURES

We have available for sale—Sounders, Telegraph Keys, Relays, resonators and other memorabilia from the 19th Century. Write for Catalog and enclose 50¢ for postage.—**J. H. Bunnell & Co., 920 Essex Street, Brooklyn, N.Y. 11208.**

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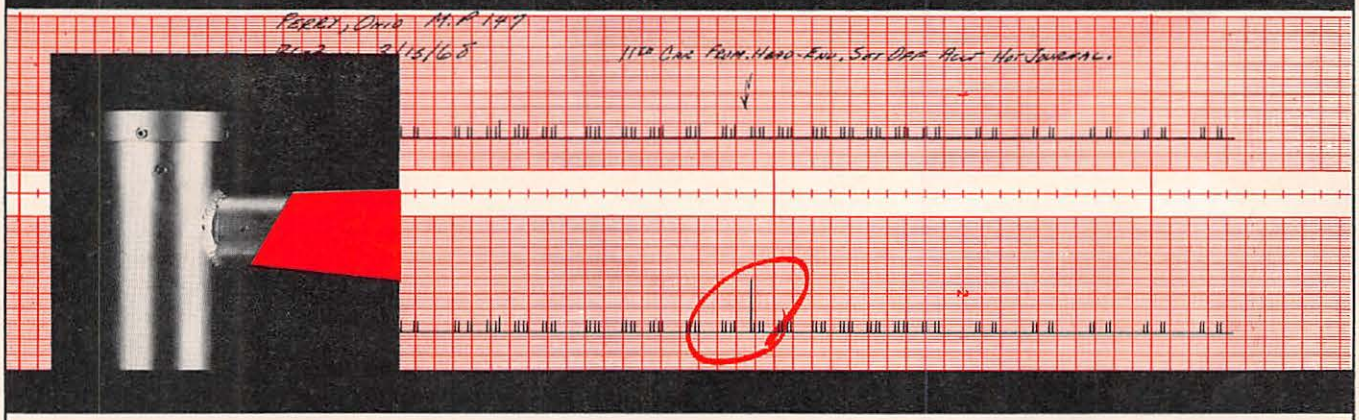

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physically protect the main line

Derails or signals? Each has its place: signals are obeyed by men; Hayes Derails are obeyed by equipment.

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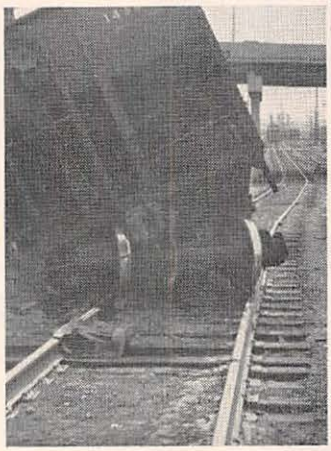

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Circle 21 on reader service card on page 38

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The answer is not always "all active." The right answer comes from calculating all possible ways to design a system, path by path, active versus passive repeaters. Only by comparing methods, will you find the lowest dollar per dB cost.

Use just one passive repeater and you'll take a microwave system design out of the dark ages of system concept. Use just one passive repeater and you'll find places to use more!

Why not compare the passive repeater design to the all-active method and judge for yourself.

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(Continued from page 36)

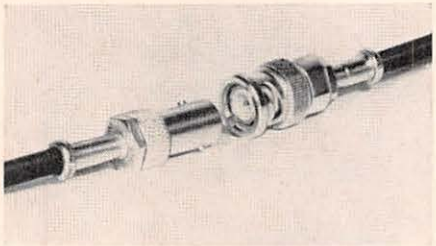
sage trunk, private line and ring-down circuits. The new brochure includes equipment description, photographs and performance information. *Lenkurt Electric Co. Inc. Circle 107 on Reader Service Coupon.*

Frequency Calibrator

Using a fast warm-up, high stability oscillator as the source, an all solid-state S1315A frequency calibrator generates a spectrum of precise frequencies from 100 kHz to 500 MHz selected by the position of the channel switch. This spectrum of frequencies includes all assigned frequencies within the band selected by the channel switch.

The transmitter frequency beats against the spectrum of frequencies generated by the S1315A and produces a zero beat with the correct frequency when properly adjusted. No tuning is required. The very steep selectivity skirts of the frequency calibrator allow the technician to set the unit being checked on frequency within cycles. The unit is accurate to 0.00001% in only 3 minutes. High stability and accuracy is assured with a daily drift rate of better than 0.000002%.

The S1315A weighs only 7 lb. It can use battery or optional AC line operation. Battery operated units are powered by nine standard "D" cells. *Motorola Communications & Electronics Inc. Circle 108 on Reader Service Coupon.*



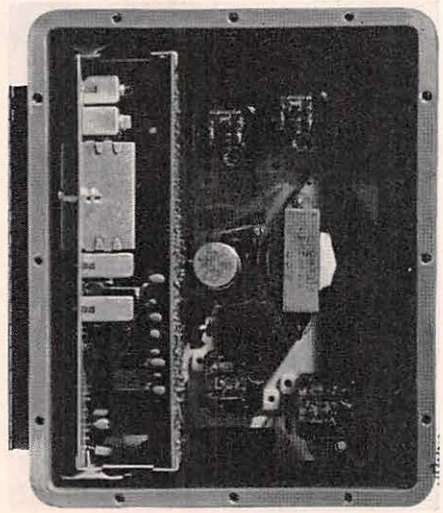
Coaxial Connectors

An exclusive one-crimp termination method makes it possible to join coaxial cable inner conductor, outer braid and cable support to connector parts simultaneously. BNC series weighs only ¾ oz. (cable plug and jack). Operating voltage is 500 volts RMS, operating temperature is −65°C to +200°C and impedance is 50 ohms nominal. *American Pamcor Inc. Circle 109 on Reader Service Coupon.*

● DATA SET: The 26C duobinary Datatel data transmission sets are capable of operating up to 2400 bps. Descriptions of the 26C including electrical specifications are provided in bulletin 26C-P4, Issue 3. *Lenkurt Electric Co., Inc. Circle 110 on Reader Service Coupon.*

● DATA SYSTEM: The 960A journal data transmission system is described in an 8-page bulletin including drawings and electrical specifications. The 960A system will interface with all common hotbox detection systems and meets operational standards of the AAR. Pulse duration modulation and frequency shift key are features of this system. *Lenkurt Electric Co., Inc. Circle 111 on Reader Service Coupon*

● TELETYPEWRITER COMPONENTS are described in bulletin 7000 and consist of tone transmitters and receivers, teletypewriter loop module controls, and regenerative repeaters. Descriptions and electrical characteristics are included. *Quindar Electronics Inc. Circle 112 on Reader Service Coupon.*



Remote Control

A new control product provides remote control by radio from a centralized location as well as handle emergencies more effectively and efficiently. The new multi-function radio switch consists of an FM receiver, power supply, decoder and relay output stage. A tone coded signal is generated by an encoder located at a central station. This tone coded signal frequency modulates the radio carrier and transmits to the receiver. At the receiver, the signal is demodulated, the tone signal decoded, and the information applied to a relay section, which in turn controls an interfacing electro-mechanical device such as an actuator.

The unit is completely solid state, except for the relay output stage. The relays are activated in a fraction of a second from the moment the signal is received by the receiver. Secure communications are provided by the multiple tone coding scheme that is both time and sequence dependent. The multiple function capability of the unit provides the flexibility of being adaptable to many different applications. Large address capacity enables one central location to control many remote locations. The switch can be mounted outdoors as well as indoors because of the weatherproof housing. *Motorola Communications & Electronics Inc. Circle 113 on Reader Service Coupon.*

Selective Signaling

A new Quik-Call II mobile paging decoder provides selective signaling capability to mobile radios. With the Quik-Call II unit, a dispatcher can call one vehicle in a fleet without any of the others hearing the call. Each driver hears only the messages meant for him. At all other times, his radio is silent. The Quik-Call II two-tone sequential decoder operates with all standard Motorola VHF paging two-tone encoders. The decoder alerts only the selected mobile in the system. If no one is there to answer, the call-lite remains on until the driver returns and answers the call.

The unit is available in three different models. First is the Call-Lite only version with individual call capability. The middle unit incorporates the Call-Lite and individual call capabilities, plus the "horn and light switch" capability. With this model, a signal from the paging encoder can activate a horn blast from the mobile or engage the mobile's emergency blinker lights. The third model incorporates the features found in both the preceding models plus group call. This enables the user to talk to a certain preselected group without interfering with other mobiles in the system.

Designed to mount on any standard Motorola MOTRAC, MOTRAN, or MOCOM 30 trunk mount radio control head, the unit can be installed in the field. *Motorola Communications & Electronics Inc. Circle 114 on Reader Service Coupon.*

● MICROWAVE systems are covered in a 28-page catalog including brief descriptions of solid-state microwave systems for operation in all industrial and common carrier point-to-point bands below the 6 GHz region. Systems described are capable of handling up to 600 multiplexed voice channels. *Farinon Electric. Circle 115 on Reader Service Coupon.*

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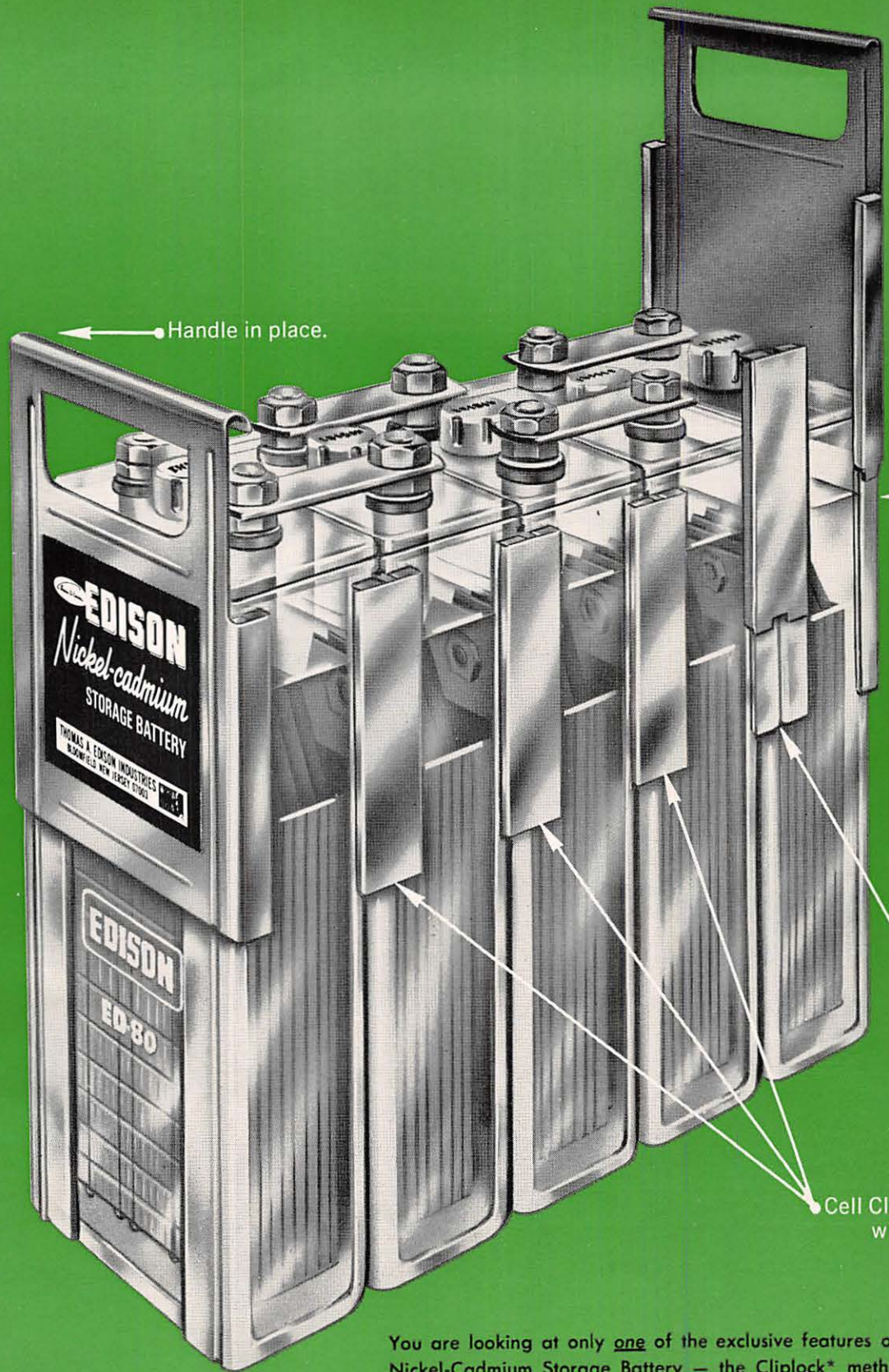
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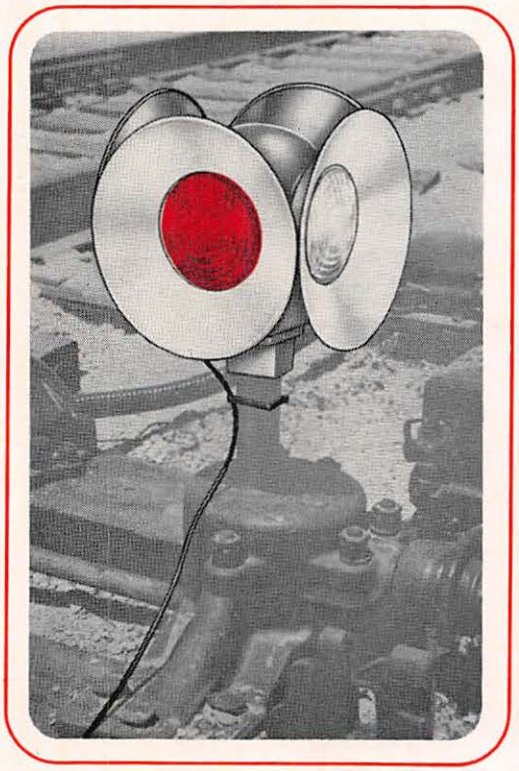
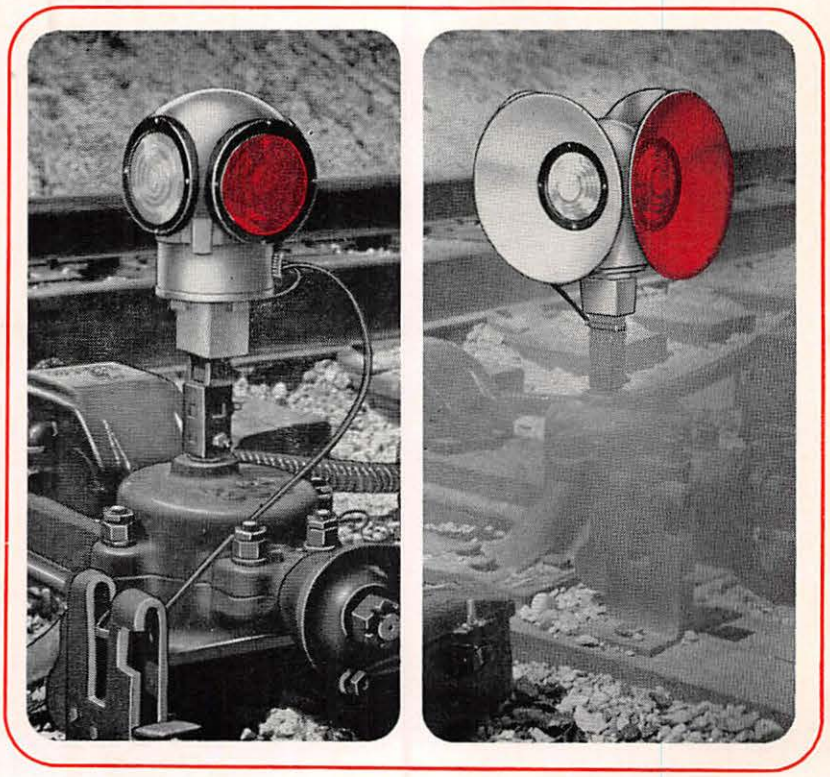


TYPE 1880-A (Aluminum) Weighs 43% less*



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